The Economics of Land Degradation

Theory and Applications to Lesotho

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Theory and Applications to Lesotho

Jan Bojö

STOCKHOLM SCHOOL OF ECONOMICS

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To my parents

Märta and Per,

who in their subtle ways inspired me to pursue my academic studies, and to my wife

Gertrud

who suffers the consequences, but remains my richest source of encouragement.

FOREWORD

As I swung the jute bag with a sample of sorghum over my shoulder and marvelled at the breathtaking view of the Lesotho mountains, I inhaled the crisp air and felt that I had found a research topic with considerable merits. There have been moments when the opposite seemed equally obvious. Closing this work on a more balanced note, I can at least take courage in the words of a friend and colleague, that "the best dissertation is a finished one".

The topic of this dissertation emanates from my work in 1985-1987 as an economic adviser to the Southern African Coordination Conference (SADCC) Coordination Unit for Soil and Water Conservation and Land Utilization. Many interesting issues passed my desk without there being sufficient time available to reflect on them from anything but a strictly operational point of view. I therefore turned back to academic life for another period of (intellectually) privileged opportunity to pursue some issues more systematically.

Karl-Göran Mäler responded positively to my research idea, and has remained my main supervisor at the Department of Economics, Stockholm School of Economics, since my work on this thesis began in early 1988. We have had several discussions on draft chapters, from which I have invariably emerged with my manuscript full of question marks in the margin, a pile of borrowed books to read, a sizeable list of references to hunt for and the sense that I had merely begun to scratch the surface of something interesting. Karl-Göran's ability to quickly spot the weakest link in a chain of arguments constructed with considerable effort has made a significant imprint on the character of this work.

My friend and former colleague, Thomas Andersson, has given many ideas and suggestions that have been of considerable importance in shaping this work. Through Thomas, I came in closer contact with the Department of International Economics and Geography at the Stockholm School of Economics, an environment which I have found inspiring. At this Department, I have had the privilege of being surrounded by a sincere and vigorous team of researchers who have generously shared their knowledge and ideas. Mats Lundahl has continuously read and constructively criticized a number of drafts of this dissertation. His great knowledge of development economics in general and of Lesotho in particular has been very important for this work. Ari Kokko has shown great insights in a multitude of issues relating to my topic of study - he has also dealt with the numerous cases of acute conflict between myself and my computer with admirable patience. Gun Eriksson's efforts to create logical structure out of chaotic drafts also deserve special mention. I have found many seminars and

discussions at the Department to be of great benefit, and all the participants in these activities deserve collective thanks. However, in addition to the persons already mentioned, special thanks go to AnnaMaria Bengtsson, Hans Bergman, Jonas Björnerstedt, Magnus Blomström, Lisa Roman, Per Ronnås, Joakim Stymne and Stefan de Vylder for their valuable comments and observations.

At other departments of the Stockholm School of Economics, I have gained a great deal from discussions with Lars Bergman, Claes Cassel, Jan Eklöf, Sune Karlsson, Tore Söderqvist and Lena Unemo. Jan Eklöf's unique combination of statistical and econometric expertise and a thorough knowledge of Lesotho statistics has been very important.

Going beyond the walls of the Stockholm School of Economics, my colleagues in a joint research effort of "Interdisciplinary Analysis of Soil and Water Conservation Projects" are Vusi Mashinini and Motlatsi Mokhothu from the Department of Geography, National University of Lesotho and Bernt Rydgren, Department of Physical Geography, University of Uppsala, later Division of Land Use Planning, Ministry of Agriculture, Lesotho. Mashinini's surveys of Basotho farmers have enhanced my understanding of their perspective on land degradation and farming. Bernt Rydgren has spent an enormous amount of time reading, discussing and criticizing in writing the numerous draft versions of this and other related work coming out of our joint research project. His comments have concerned everything from the fundamental philosophical issues behind the concept of "sustainable development" to the placing of commas, and have also been important over the whole range of issues in shaping this work. I suspect that some of his observant linguistic remarks ought to make me grateful to his wife, Ruth Farrior-Rydgren, who is equipped with a natural comparative advantage in this respect.

The field research in Lesotho pertaining to the Farm Improvement with Soil Conservation Project (FISC) would not have been possible to carry out without the kind help of many people listed as an appendix to chapter 5. A number of people associated with Swedforest Consulting AB, which is the implementing company of FISC deserve special mention. The Team Leader of FISC, Gedion Shone, has been extremely cooperative, a tremendous source of knowledge, a delightful host and a master of Ethiopian cuisine. If soil conservation will ever succeed in Lesotho, it must be with people of his integrity and sincerity in charge. Several of the project staff, including Morero Kesi, Anastasia Mabetha, Idris Mohammednur and W. Molapanyane made important contributions in the field work. I also want to mention the encouraging interest and help I received from Lennart Annersten, David Palin and other personnel at Swedforest Consulting AB in Sweden. It is a sign of the genuine

integrity of all these people that they have never failed to encourage this research, although we have often respectfully disagreed.

Other field work in Lesotho concerned macroeconomic aspects of land degradation. I am indebted to a considerable number of people for information on this point, and I am impressed by the openness and friendliness of many Basotho administrators. I want to thank them and other contributors to this theme collectively with reference to the list attached to chapter 3.

This work has forced me to deal with much information outside the usual scope of economics. The help of several physical geographers and soil scientists has been important in this respect. Lennart Strömquist, Uppsala University, has provided important guidance and encouragement pertaining to large parts of this work. Carl Christiansson, Stockholm University, Iris Ronqvist, Agricultural Board of Gotland, and Michael Stocking, University of East Anglia, have also made essential contributions on several issues.

On the account of statistical information and interpretation, personnel of the Lesotho Bureau of Statistics and Statistics Sweden have made vital contributions. Nthunya Joe Mohapi, Jan Redeby and Staffan Wahlström kindly supplied statistics of vital importance to this study. Per-Olof Olofsson made an authoritative contribution regarding crop sampling procedures.

Lennart Petersson, Lund University, generously took his time to share with me excerpts from his collection of literature on Lesotho. Renato Aguilar, Gothenburg University, provided advice on econometric procedures. Annika Dahlberg, Stockholm University, contributed as an unpaid freelance researcher while in Lesotho on other business, apart from her professional work as reflected in my references.

I have re-shaped and expanded upon several of my previously published works to arrive at this dissertation. The reader will find them listed as references in the chapter(s) for which they are relevant. Particularly important in this respect was the rewarding joint work resulting in the book "Environment and Development: An Economic Approach" together with Karl-Göran Mäler and Lena Unemo. My participation in the two volumes on "The Economics of Dryland Management" by John Dixon and colleagues was another important source of inspiration for this work.

Bill Harris has skilfully tried to make my English readable even to the non-Swedish speaker. The responsibility for any typing errors rests with me, but the kind assistance of Carin Blomkvist and Britt Rosen with some last-minute editing is acknowledged. My friend

"Dudu" (Eduardo Coelho) from Maseru, Lesotho, is warmly thanked for the original drawing which appears on the cover of this book.

This research was made possible through a grant from the Swedish Agency for Research Co-operation with Developing Countries (SAREC), and additional financial support from the Government of Sweden which is hereby gratefully acknowledged. Gertrud Bäckström, Rune Castenäs, Majgund Fredholm, Saara Mekras and Pirkko Olsson have been very helpful with financial matters.

I used to think that the common paragraph in the forewords of dissertations with thanks to the family for their "unfailing support" was somewhat trite. I now know better. In my own experience, research has a propensity to deform one's personality into that of an absent-minded zombie, who in search of the Truth alienates his social surrounding and loses both friends and material possessions, forgotten in transit from research at home and research at the office. Nevertheless, my family has remained a genuine source of emotional inspiration and a healthy counterweight to the treacherous maelstrom of academic research. I hope to be able to prove to them that the negative externalities they have experienced need not remain genuine externalities in an intertemporal context.

The significant and generous contributions of all these people notwithstanding, the final responsibility for the selection of facts, advice and interpretations rests with me.

Stockholm School of Economics
June, 1991

Jan Bojö

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1. INTRODUCTION AND SUMMARY

1.1 Introduction

This book concerns itself with land degradation and, by implication with its opposite: land improvement. However, it is inspired by the wide and fundamental issues pertaining to sustainable food production. By the end of this century the world's population will have surpassed 6 billion. Does land degradation pose a significant threat to the food security of this population? What are the driving forces behind land degradation? How can economics contribute to macroeconomic policies that enhance land use, and microeconomic interventions that combat land degradation efficiently? These are the fundamental questions from which the present work emanates.

Purpose

The purpose of this dissertation is to analyze land degradation from an economic perspective in order to assess its **significance**, understand its **causes** and design possible **remedies**.

Delimitations

The first delimitation is one of specifying more exactly the **subject matter**. The starting point for our discussion is land degradation and improvement. As will be argued later, there should be no strict separation between "defensive" soil and water conservation measures, aimed at resource preservation, and improvements of farm management in order to raise productivity. Furthermore, it will be argued that there are important direct as well as indirect links between general, economic and other policies, and land utilization. This makes it difficult,

not to say impossible, to exactly circumscribe the relevant field of study. However, the focus here is on how all these aspects pertain to land degradation, and the wider question of agricultural development in general is not addressed in all its aspects.

The second delimitation is one of **geographical scope.** Land degradation is a considerable problem affecting both industrialized and developing countries, although the impact on people's livelihood is much more dramatic in the latter category. The theoretical discussion will be broad and pertain to a rather general context. By necessity, however, the empirical focus will be more narrow. For reasons of relevance, representativity and cost-efficiency, the choice has been to use Lesotho in Southern Africa as the case study.

As discussed in chapter 3, Lesotho is often considered to exhibit one of the worst cases of soil erosion in southern and central Africa, making the example of Lesotho a relevant one when illustrating the problem of land degradation. While the case of Lesotho is by some considered to be extreme, the basic features of land use with livestock management on communal rangeland and traditional smallholder crop cultivation are common enough to be representative for many other developing countries. Thus, this case study should have some implications beyond its own borders, although institutional and other circumstances differ substantially between countries.

In the choice of case study, there is also the consideration of cost-efficiency imposed by limited research funding. The author served as an Economic Adviser to the Coordinator for Soil and Water Conservation and Land Utilization Sector of SADCC (Southern African Development Coordination Conference) in 1985-87. The Coordination Office is based in Maseru, Lesotho. This position provided first-hand experience and contacts with human and written sources of information, without which this kind of research cannot be undertaken. For these reasons, Lesotho, and a specific project within this country, will be the subject of particular attention in the present work. The project is called the "Farm

improvement with Soil Conservation Project", and will be referred to as "the FISC project", or simply "FISC".

A third delimitation is one of **time perspective**. Although a brief discussion will concern conservation efforts during colonial times, as well as more recent international and national efforts, there is no attempt to write a history of land degradation. The focus of this work is on today's and tomorrow's problems of countering land degradation.

The fourth delimitation is mentioned already in the purpose, but needs to be re-stated explicitly; an **economic perspective** on land degradation is applied. This is said in respect to other disciplinary perspectives which are equally legitimate and complementary in the joint search for improved land management. Some attempts are made to understand and incorporate elements of other disciplines, but limitations of competence will restrict the perspective to what is primarily an economist's view of an interdisciplinary problem.

Approach and Methods

The author is, of course, influenced by training in a particular research paradigm (Kuhn, 1962), which defines the boundaries and avenues of acceptable research. On a high level of generality, this work can be placed in the neoclassical tradition of economics. The choice of analytical perspective to some extent also defines the methods that are legitimate. This is subject to considerable debate, and the present author is not entirely unaware of the options available.[1] However, this is not the proper place to address these far-reaching issues, and an explicit statement of the choice made will be taken to suffice here.

From a **macroeconomic** perspective, land degradation as an economic problem (non-optimal depletion of land) is viewed here as the result of deviations between private

1. See Colby (1990), Daly and Cobb (1990), Goodland and Ledec (1987), Naess (1973), Ophuls (1977), Page (1977), Randall (1987), Schumacher (1973) and Swaney (1987) for different perspectives on the economics of environmental management, and examples of criticisms against the positions taken here.

and social rationality. The neoclassical benchmark model of a perfectly competitive economy with universal markets is taken as an analytical point of departure, although certainly not as a good description of the actual state of the world. Thus, the search for causes behind land degradation is conducted along the avenues of market and government failures affecting land use. From a **microeconomic** perspective, the author takes the view that cost-benefit analysis, properly amended to account for environmental impacts and equity considerations, is a useful tool in the analysis of land degradation and improvement.

Proceeding to a more technical level of choice of method, there is no attempt here to model land degradation in a general equilibrium framework. Rigorous modelling of the impact of various policies on land degradation would be a formidable task, and the necessary data to estimate such a model econometrically is not readily available. Specific aspects of land degradation lend themselves more easily to modelling and estimation, and have been possible to deal with within the confines of this research project. Econometric estimation of erosion-production relationships and cost-benefit calculations based on project performance scenarios are examples given in this work. However, much of our "modelling" is qualitative and verbal rather than quantitative and mathematical. This is a result of the considerable complexity of the interlinkages, the poverty of empirical data, as well as a choice based on personal preference.

Proceeding to the most basic level of the methods utilized, there are several important sources of information used in this work. Primary data have been collected through crop sampling in the FISC project area, specifically designed as a part of this research project. On several accounts, the FISC project's data gathering has been adapted to respond to the questions posed by this research.

A substantial number of personal interviews with key personnel within the public and parastatal administration of Lesotho, and personnel related to the FISC project, have been undertaken by the author. The interviews have been important both in securing a substantial number of unpublished documents, but also in uncovering non-written

information, including "not-to-be-written", but indirectly useful information. More or less formal interviews and consultations have also taken place with various subject matter specialists in Lesotho, Sweden and elsewhere. A list of interviewed and consulted individuals is provided at the end of chapter 3 and 5 respectively.

This work is also based on literature studies on several themes:

- physical and economic assessments of land degradation;
- experiences of soil conservation;
- erosion-production/productivity functions;
- market failures and land use;
- public policies and land use;
- general cost-benefit analysis;
- cost-benefit applications to land improvement projects;
- the application of all these themes to Lesotho.

The information gathering as structured, continuous research began in January 1988 and ended in June 1991. However, before that period, the present author lived in Lesotho from July 1985 to July 1987. There were also visits to the country in April 1985, October-November 1987, May 1988, April-May 1989 and October-November 1990.

Disposition

A condensed summary of chapters 2-5 is given in the latter part of this chapter. The more detailed organization of the text is presented in each chapter and only a general overview is given here. Leaving the current chapter aside, this book has four main elements organized in a two-by-two structure shown in figure 1.1.

Figure 1.1 Disposition of Chapters (Chapter no.)

	General	Specific
Macro level:	2	3
Micro level:	4	5

The term "macro" is used here to denote the national economic perspective and "micro" signifies the project and household level of analysis. The "general" chapters 2 and 4 contain a review of general but relevant theory and empirical evidence. The "specific" parts concern Lesotho as a nation (chapter 3) and a specific project in Lesotho (chapter 5). The logic behind this organization is that the two more general chapters provide a background and analytical structure to the problems discussed in the more specific ones.

The contribution, if any, of the more general chapters is therefore a particular, and hopefully useful synthesis and discussion of the rather substantial literature available, whereas the contribution of the more empirically oriented chapters 3 and 5 is to bring forth new empirical data and a new analysis of existing data.

1.2 Summary and Conclusions

This summary represents a condensed version of individual chapter summaries, and is primarily intended as a guide for the reader who wishes (to decide whether or not) to read selectively from chapters 2-5.

Land Degradation: Extent, Causes and Remedies

Land degradation commonly denotes a loss of land productivity. However, declining productivity is not necessarily in contradiction with rational, and even optimal behaviour. It is when the rate of degradation is off the social welfare maximizing path that land degradation is "excessive" and constitutes an economic problem.

Evidence on the physical extent of land degradation is patchy, particularly in developing countries. However, the most thorough estimates available, indicate a severe magnitude of land degradation striking some of the world's very poorest.

Economic assessments of land degradation are fewer the more aggregate the scope of analysis. Estimates are often based on unreliable data. Quoting any figures is abstained from here, as they would contribute more to the folklore about conservation than to rational debate. Some estimates indicate that the resources required for conservation investments would be within reach of a joint effort of developing country farmers, national governments and the international community of donors. Considerable resources should be possible to mobilize for financially profitable investments through regular markets, if these are allowed to operate freely.

Land improvement programmes and projects are not often evaluated from an economic point of view to an extent where conclusions about their success can be made. Available evaluations often indicate failure. There are examples of projects considered "successes". It is often not clear what criteria have been used for the evaluation. Sometimes physical input achievements are quoted as proof of success, without any consideration of resource cost. The massive record of failure has prompted a search for a new soil conservation strategy. Key

elements in this strategy are an emphasis on production rather than preservation, people's participation, and low-cost, labour intensive technology.

The dismal record of past soil conservation efforts has also inspired a search for the more fundamental causes behind land degradation. It is proposed here that market failures create deviations between privately and socially optimal behaviour, making socially excessive land degradation privately rational. Unless these fundamental distortions are dealt with, micro level efforts to improve land management will remain partial and ineffective.

There is a case for both social intervention to deal with market failures, and for careful design of such intervention. This includes the removal of distortionary policies that promote land degradation. It is proposed here that policies pertaining to property rights definition and enforcement, population growth and distribution, price regulation, international trade, taxation, the role of political élites, public investments, information and decision-making are all potentially important in relation to land degradation. It is, of course, an empirical matter to what extent this relationship is significant.

Land Degradation from a Macroeconomic Perspective: The Case of Lesotho

Lesotho is a low-income developing country, geographically, politically and economically encircled by the Republic of South Africa (RSA). Roughly half of the GNP is made up of incomes from migrant labour in the RSA. Agriculture is under relative economic decline. Its main elements are livestock management on communal rangeland and traditional crop production suffering from adverse climatic conditions.

There are no previous estimates of the economic significance of erosion for Lesotho. An attempt is made here, showing no statistically significant impact of accumulated erosion on crop land on the national aggregate production of maize and sorghum. The district level analysis shows no significant negative influence of erosion on the time trend of crop yields.

Given some alarming accounts of the extent and speed of the erosion process in Lesotho, these results may appear surprising. However, they do coincide with the low ranking of erosion among agricultural problems from a farmer's perspective that have been reported in several surveys.

While we cannot derive estimates of the soil loss-production damage function from the econometric results, other evidence is used to suggest an illustrative "guesstimate". The macroeconomic significance of a postulated erosion-production relationship of 1 percent decline per annum is discussed, and measures of net economic loss are calculated. This is done to illustrate possible immediate loss due to current erosion (NAIL), the net present value of future losses due to current erosion (NDIL) and the net present value of cumulative future erosion (NDCIL). Their relationships to macroeconomic indicators of the strength of the economy are also discussed.

Parameters for the policy analysis must be set by the political authorities in Lesotho, following more profound research into the underlying agronomic relationships. The point here is to illustrate the implications of a set of debatable, but explicit and not unreasonable assumptions. Although the illustration used here may exaggerate the actual problem, the largely irreversible character of land degradation, coupled with its propensity to strike the poorest segment of the economy, adds weight to the need to call political attention to the problem.

Externalities on grazing land are a key environmental problem in Lesotho. On crop land, on-field impacts have good prospects of being internalized. However, off-field impacts and crop residue grazing cause negative externalities. Some conservation structures have a public good nature and cannot be efficiently supplied by private initiative. There is a potential role for communal land management, backed by national legislation, training and research.

The average farmer in Lesotho has limited access to formal future and risk markets. However, real rates of interest for agricultural credit are low, and this study

casts some doubt on credit supply as an important constraint for investments in land improvements. There are substantial migrant remittances as a source of capital. High risk is probably a major deterrent to improved crop management, but a formal crop insurance market has not developed in Lesotho. Some risk is absorbed by credit institutions who rarely proceed to take legal action in cases of default.

Turning to government policies, past land improvement efforts have largely been unsuccessful. Recent conservation efforts are better integrated in agricultural development schemes, but the major government programme in this field lacks a soil conservation component.

The legislation pertaining to conservation of land is rigorous, but generally not implemented. It often lacks subordinate regulations and provisions for effective enforcement. Property rights to crop land provide for inheritance and secure usufruct rights. However, there is no legal market for the sale of rural land, which prevents efficient re-allocation. Leasing arrangements that could ensure more efficient management of crop land are hampered by the lack of a legal framework.

The lack of enforced communal property rights on range land makes the regime approach one of "open access", and encourages overstocking by privately rational farmers. Ongoing work to re-adjudicate cattlepost grazing rights is a step in the right direction, but will still take many years to complete. The establishment of Range Management Areas is being promoted, but experience has shown them to be crucially dependent on external, donor-funded support. Efforts are currently being made to introduce a national grazing fee for livestock. While this would serve to internalize the externalities on the range, the obstacles for implementation are severe. The options of locally determined fees, or marketable grazing permits have been neglected in the debate.

Lesotho lacks a population policy, and there is little political concern voiced over the population growth of 2.6 percent per annum. The rural "surplus" population forms a growing stratum of landless without livestock. The formal sector has poor absorption capacity and

prospects for future migrant work in the RSA are uncertain. With an overgrazed range land and no extra crop land to allocate, the growing number of rural poor will aggravate the environmental pressure from a group that cannot afford to consider long-term sustainability. It should be recalled, however, that the recent political changes in the RSA may radically change the prospects for general migration from Lesotho.

Domestic price regulation is very limited in Lesotho. There is some price raising impact on agricultural output from the RSA which encourages cultivation, leading to aggravated land degradation under current land use management in Lesotho. The trade policy is defined by Southern African Customs Union membership, and entails import barriers to foreign agricultural produce. Income taxes and indirect taxes play a limited role in the Lesotho economy, and public revenue is based primarily on customs income. On these accounts, there are virtually no possibilities to pursue a separate domestic policy.

The current political élites and the bureaucracy base their power on military rule, traditional chieftainships and the underlying consent of the Pretoria Government. Measures to alter the property rights of rangeland are difficult to implement, due to the perceived interests of élites with considerable livestock ownership. Reforms to create a commercial market for land conflicts with the interests of the chiefs and their traditional privilege to allocate crop land. The generally low efficiency of the bureaucracy hampers the implementation of land improvement programmes.

The review of public spending shows that the major public investment programme - the Lesotho Highlands Water Scheme - is equipped with ambitious plans for the improvement of areas affected by the project. If these plans are implemented as intended, the net impact will be a land improvement in the surrounding areas. Public information and debate is circumscribed by the government's dominance over domestic media and the ban on party politics. The latter may change soon, as elections are announced to take place in 1992.

In conclusion, the most important policy areas for Lesotho Government intervention in relation to land degradation appears to be property rights re-definition and enforcement and population growth. Democratic reforms will hopefully encourage an open and vital debate about these issues.

Cost-Benefit Analysis of Land Improvement Projects: Theory and Applications

Even after a **realistic** degree of general policy reform to improve land management, there is a role for specific projects in order to combat land degradation. Projects are also likely to continue, as they fit the donors' institutional requirements. As resources are limited, they have to be carefully directed in order to ensure efficiency. This is where cost-benefit analysis (CBA) has a vital role to play.

A review the theory of CBA and its application in 20 empirical analyses of land improvement projects brings out the following main points.

As theory suggests, the evaluation criteria used for assessing project worth are the Net Present Value (NPV), the Internal Rate of Return (IRR) and the Benefit-Cost Ratio (BCR). A few studies refer to pay-back periods. This may result in misleading advice, and care must also be exercised with the IRR and BCR in project selection. Conflicting ranking according to multiple criteria is not always clearly resolved.

Income distribution has been given considerable attention in the academic literature on CBA. It is discouraging to find that so little is done empirically on this point. Empirical difficulties of data gathering is an important constraint, but also the attitude that distribution is outside the appropriate analytical scope.

Identification of costs and benefits present few theoretical problems, but may cause difficulties when delineating the area of analysis in practice. Benefit identification is largely confined to the immediate project area, with few studies considering off-site impacts and secondary effects on the community at large.

Regarding the assessment of quantitative variables, the review on this point underlines the need for substantial research on erosion-productivity relationships. A few advanced, general models are available, but they are poorly suited for developing countries. Even simple empirical research on erosion-productivity functions is rare in developing countries, which is reflected in the general weakness in reviewed studies on this point.

The deviation between the financial and economic prices can be considerable in highly regulated economies, and some items may not be priced financially at all. This requires estimation of economic prices. Empirically, this problem is solved by anything from careful and detailed reasoning to ad-hoc adjustments. Attention to changes in real prices over time is extremely limited.

Discounting is a controversial subject. The notion that particular environmental considerations should affect the choice of social discount rate is discussed, but rejected here. Such concerns can be more adequately addressed by other adjustments in the CBA. Applications to land improvement projects reveal little or no preoccupation with the method for selecting a rate, and only passing references to its empirical basis. Nevertheless, there is some convergence around the real rate of 10 percent.

Theoretically, an infinite time horizon should be considered in order to encompass the full impact of a particular project. In practice, this is unnecessary when impacts are short-lived. This issue is given scant attention in applied studies. Usually, a period of 10-20 years is postulated.

Given uncertainties pertaining both to the project itself and external factors, the net present value is not a single number, but a set of values with a probability distribution attached. Empirically, the answer to uncertainty is commonly sensitivity testing of major variables to illustrate how changes in assumptions alter values of evaluation criteria. The testing is commonly done by simple rule of thumb rather than by reference to probability estimates.

As for policy conclusions, a number of the reviewed studies have pointed to the need to equalize the financial and economic returns through some form of public intervention. Some argue in favour of subsidies also to financially attractive projects, without posing the question as to why private households are unable to capture these opportunities themselves. The excess burden cost of public interventions is never discussed. This might reflect the fact that many land improvement projects are funded by foreign grants, taken as given from the recipient country perspective.

In conclusion, there are considerable gaps between the sophistication of CBA theory and its empirical application to soil and water conservation projects. Applied studies often neglect to specify the basis for crucial assumptions. Quantification of the production impact of conservation measures remains troublesome, requiring a concerted research effort. Distributional issues are generally disregarded. While some studies give a mechanical impression, the range of quality is considerable, and the best ones can serve as examples.

Cost-Benefit Analysis of Land Improvement Projects: A Case Study in Lesotho

The choice of the Farm Improvement with Soil Conservation (FISC) project as an object of study is justified by its features coinciding with the a modern approach to deal with land degradation: production orientation, labour intensive techniques and popular participation. The project area is fairly typical for Lowland Lesotho, were most of the crop production takes place. With some adjustments, the model of calculations could be used for other areas in Lesotho, or other areas with similar features in other countries.

The overriding aim of the FISC project is to raise agricultural production. In pursuit of this goal, the project has promoted mechanical soil conservation structures, hybrid maize and sorghum, fodder grasses, tree planting for fruit and fuelwood and rotational grazing on communal land.

The FISC project was initiated in 1985 in Mohale's Hoek District in southern Lesotho, and is gradually being expanded. The project is now used as a model for a national training programme in soil conservation. Other soil conservation projects already use FISC as a model. This underlines the importance of studying this experience.

The **financial** analysis is done from a household perspective, using market prices. Two management options for cultivation of maize and sorghum have been compared in financial terms. The "high input" alternative implies the use of commercial fertilizer and hybrid seed. The "traditional" alternative implies no use of fertilizer and locally saved seeds instead of hybrids. The less immediate impact of soil conservation measures is left out of the crop calculation, which pertains to one year only.

Crop sampling has been carried out in cooperation with the FISC staff during five seasons (1986-1990) as a part of this research. The results show that farmers using a "high input" management receive higher yields on average, but that very substantial variations of yields makes this a risky investment.

Financial calculations for maize and sorghum show the requirement for yield increases, in order to achieve a real rate of return of 10 percent. The requirements are significantly higher than the average actually achieved under "high input" management as sampled, which gives a negative real marginal IRR.

Maintained application of the project recommended input package appears limited after the initial boost when conservation efforts result in in-kind payments of agricultural inputs. Most likely, project sales are merely replacing alternative suppliers. There are no convincing signs of a major transformation of the crop management regime. The long-term impact of physical conservation works may be the only net impact, as far as the major grain crops are concerned. However, financial budgets for fruit and fuelwood trees show more promising returns.

The **economic** part of the analysis considers the perspective of the Lesotho Government and the donor organization (SIDA). Project performance has been recorded for the period March 1985 to December 1990. Current, firm plans for work until mid-1992 have been incorporated, and extrapolations have been made from past performance in relation to future budgeted financial means. As for the period after 1992, the following assumptions have been made.

As for costs, it is assumed that domestic authorities try to uphold the services provided by the project, using domestic personnel and resources left behind by FISC. The level of costs is assumed to remain as the average for 1985-1992, but with all costs associated with expatriate personnel taken out. This implies a level of approximately half the previous average. As for benefits, a comparable performance level is assumed.

Given these assumptions, the results of the base case are that the project makes a net present loss that is significant in comparison to the resources invested. In terms of the overriding target for the project - to raise agricultural production among smallholder farming households - the project cannot be shown to be successful, when the benefits are related to the costs. It is important to note that this cannot be attributed to poor management of this particular project.

The robustness of this base case result are tested using sensitivity analysis concerning alternative assumptions regarding:

(1) discount rate
(2) post-1992 project performance
(3) fruit income
(4) erosion impact on crop yields
(5) future grain prices
(6) distributional weights

The qualitative impression of the sensitivity analysis is that, if the discount rate of 10 percent is used, the base case result remains robust, although the size of the deficit is changed. Distributional weights could possibly justify either continued donor funding in spite of poor efficiency, or a dismantling altogether of all

activities, but not a continuation of the project under domestic funding.

However, if the lower discount rate of 1 percent is considered acceptable as a standard, the base case result could be qualitatively altered by several factors making the project perform better than expected. With the lower rate, the project could also be justified using a heavy distributional weight. However, this weight should then be consistently applied to alternative projects.

Some **intangibles** should be noted in addition to the present value calculations.

(1) Secondary community benefits due to increased spending are very limited locally. Most of this will leak out to the RSA, and constitute a cost to the donor rather than a benefit.

(2) An explicitly neglected cost item of potential importance is the labour cost for maintenance of soil conservation works. Estimates for labour requirements differ considerably, but in the base case the judgement of the Project Team Leader is used. This means that the cost is considered negligible. However, an alternative assessment indicates that conservation benefits could be nil if the discount rate of 10 percent is used, and substantially reduced if the discount rate of 1 percent is used. Empirical research is needed on this point, not only for this case, but to strengthen the literature on this neglected point in general.

(3) As of early 1991, the "FISC model" has been placed at the centre of national conservation training. Considerable expectations are attached to the use of FISC experience for national level replication. It can be argued that many of the elements of FISC are not really new. The history of soil conservation projects in Lesotho is long, the promotion of fertilizer, hybrid seeds and fuelwood trees is well established. Attempts to encourage growing of fruit trees and fodder grasses have also occurred. More novel is the emphasis on training of local people and of institution building. It is too early to judge the impact of this programme on the national level.

(4) An additional point is option value. Lesotho is extremely dependent upon migrant labour remittances. From both a macro and a micro perspective, the soil conservation programme is an "insurance" against declining migrant work and the implied growing importance of agriculture. This leaves the decision-makers with an only partially quantified problem: is the present value of the option to utilize land of better quality, higher than the negative NPV of the project?

However, soil conservation is not the only possible "insurance" against declines in migrant labour incomes. Lesotho needs **food security**, not necessarily more domestic production of grain. If an economic capacity to buy grain on the world market can be established through other development projects, this may be more efficient. Lesotho has a comparative advantage in inexpensive labour, not in good agricultural land and a beneficial climate. Furthermore, the capacity to ensure food security is dependent on the **size** of the population, a neglected matter which needs urgent attention.

If the value of a project like FISC is not so much immediate production raising, but to a significant degree protection of the land base, there could be a basis for subsidizing cover crops at the expense of traditional cropping. Even if fodder could not be cut and sold at a profit, the grower would provide an "insurance service" while protecting the land. The economics of this option need to be worked out.

This study cannot conclusively provide an answer to the future value of the FISC project, but has given some reason why national-scale replication of FISC involving a substantial number of expatriate personnel should be avoided. Attention to broad policy measures affecting land use, and a primary reliance on domestic personnel, supplemented by a few expatriate trainers are better options.

REFERENCES

Colby, M.E., 1990: Environmental Management in Development. The Evolution of Paradigms. World Bank Discussion Papers, No. 80. Washington, D.C.

Daly, H.E. and Cobb, J.B. Jr., 1990: For the Common Good. Redirecting the Economy toward Community, the Environment, and a Sustainable Future. Beacon Press. Boston.

Goodland, R. and Ledec, G., 1987: "Neoclassical Economics and Principles of Sustainable Development", pp. 19-46 in Ecological Modelling, No. 38. Elsevier Science Publishers. Amsterdam.

Kuhn, T.S., 1962: The Structure of Scientific Revolutions. The University of Chicago. Chicago.

Naess, A., 1973; Ökologi, Samfunn og Livsstil. Universitetsforlaget. Oslo.

Ophuls, W., 1977: Ecology and the Politics of Scarcity. Prologue to a Political Theory of the Steady State. W.H. Freeman & Co. San Francisco.

Page, T., 1977: Conservation & Economic Efficiency. An Approach to Materials Policy. Resources for the Future. Johns Hopkins University Press. Baltimore.

Randall, A., 1987: "Institutional and Neoclassical Approaches to Environmental Policy", pp. 205-224 in Phipps, T.T., Crosson, P.R. and Price, K.A. (eds.), Agriculture and the Environment. Resources for the Future. Washington, D.C.

Schumacher, E.F. 1973: Small is Beautiful. A Study of Economics as if People Mattered. Sphere Books. London.

Swaney, J.A., 1987: "Elements of a Neoinstitutional Environmental Economics", pp. 1739-1779 in Journal of Economic Issues. Vol. 21. No. 4.

2. LAND DEGRADATION: EXTENT, CAUSES AND REMEDIES

Introduction

What is "land degradation"? To what extent is it a problem? What measures have been taken to counter land degradation? Have they been successful? These are some basic questions that provide a starting point for this chapter. As will be shown, the experience of measures to combat land degradation survey is predominantly negative, which leads on to another key question: What are the driving forces behind land degradation that land improvement projects have largely been unable to deal with? The **purposes** of this chapter are to define the problem of land degradation, assess its importance, and establish a macro level analytical framework to be applied in the next chapter.

The organization of the chapter is as follows. In section 2.1, some basic concepts related to land degradation are clarified. Available evidence of land degradation is reviewed, starting with physical assessments and proceeding to economic ones. In section 2.2, there is a survey of attempts to counter land degradation. The reasons for failure and success are discussed, and some important points for the re-direction of future efforts are noted. The dismal record of land improvement efforts has prompted a search for a better understanding of the causes behind land degradation. Therefore, in section 2.3, the driving forces behind land degradation are analyzed from an economic perspective. Section 2.4 summarizes the chapter.

2.1 The Extent of Land Degradation

Land degradation is often perceived as one of the most serious global environmental problems today. The purpose of this section is not to go into details, but to get a general idea of what the extent of the problem is. Most accounts on this matter have been written by non-economists. Their focus has generally been on physical measures. Later in this section, the turn comes to monetary assessments. However, there is a need to clarify the terminology first.

2.1.1 Some Key Concepts

Basic concepts like "land degradation", "erosion", "desertification" and "conservation" are used with different denotations by different authors. The widest concept of negative change is "land degradation" which can be understood as "... a loss of land productivity, quantitatively or qualitatively, through various processes such as erosion, wind blowing, salinization, waterlogging, depletion of nutrients, deterioration of soil structure, and pollution." (Dudal, 1981, p. 4).

It has been suggested that a distinction could be made between resource "degradation" and "depletion", as the former is clearly attacked to negative connotations (Larson and Bromley, 1990). This serves to bring out an important and controversial point. It has been demonstrated that it may be optimal to extinguish a resource that is, in principle, renewable (Clark, 1973). This implies that letting **some** lands degrade to the point of zero productivity may well be a wise course of action.

This may seem to contradict the notion of "sustainable development". However, permitting degradation to take place releases resources otherwise used for soil conservation to be used for other welfare enhancing activities. Furthermore, if the proceeds from the "mining" of soil are appropriately invested, this could compensate for the loss of land productivity. If "sustainable development" is taken to mean that the **total** stock of resources - physical and human capital as well as natural resources - does not decrease, then some

degree of land degradation is compatible with this notion of a desirable future path. It is when the rate of land degradation is off the social welfare maximizing path that it becomes an **economic** problem.

The question remains to what extent one can assume that actually observed land degradation represents an economic problem, or merely the manifestation of optimal depletion. This is an empirical question, and depending on the institutional environment, analysts have concluded that the socially and privately optimal rates of land degradation are largely the same (McConnell, 1983), or that privately rational individuals may be forced to degrade land on a tragical path to self-extinction (Perrings, 1989).[1] We shall return to this key issue below. As the suggested distinction between "degradation" and "depletion" requires a considerable set of empirical information to be determined, we shall use the term "land degradation" in its common, general meaning of "productivity loss", while being aware of the fact that only a sub-set of this represents a cause for economic concern.

Dudal's definition of land degradation showed that there are several types of processes involved. "Erosion" is one of them and composed of "... all processes that act to mold and wear down the Earth's surface features." (Encyclopaedia Britannica, 1979). Erosion occurs in a natural ("geological") as well as in a man-made ("accelerated") form. Soil erosion is a process consisting of (a) the detachment of individual particles from the soil mass and (b) their transportation by water or wind. To a greater or lesser degree, erosion is counter-balanced by natural soil formation, although this is generally a very slow process (Morgan, 1979; Hudson, 1986). The extent of erosion is determined by a complex web of factors categorized as climate (precipitation, temperature, frost and snow, seasonality and wind), relief, soil, vegetation and land use (Jansson, 1982).

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1. McConnell assumes a well-functioning market economy and complete certainty. He explicitly excludes off-farm externalities from consideration. See Kiker and Lynne (1986) for a critical discussion. Perrings is concerned with subsistence level farming in an open agrarian economy.

Physical geographers also differentiate between a number of different types of erosion, depending on their physical features. The often used concept of "sheet erosion" is rejected by Hudson (1986) as it conveys a misleading image of a uniform removal of thin sheets of soil. The term "interrill" erosion is suggested instead. This is distinguished from "rill erosion" which signifies the creation of small channels, that can be eliminated by ordinary agricultural implements. "Gully erosion" signifies a more serious form when the channel has become so big that it becomes a physical obstacle for normal cultivation.

"Desertification" is an increasingly used, but controversial term. More than 100 definitions have been observed in the literature (Glantz and Orlovsky, 1986). A widely quoted definition is that adopted by the UN Conference On Desertification (1977): "Desertification is the diminution or destruction of the biological potential of the land, and can lead ultimately to desert-like conditions." (UNEP, 1984, p. 12). Some authors use the term to denote a situation rather like what has been defined as "land degradation" above. Others prefer to use it to signify only an extreme form of land degradation. It should be recalled that the word "desert" in the strict sense of the word usually refers to places with a mean annual precipitation of less than 250 mm. Places that receive more, but are devoid of vegetation, are called "edaphic deserts" (Encyclopaedia Britannica, 1979).

"Conservation" is sometimes taken to equal passive "preservation", but this is not the common usage today. Soil and water conservation includes quite a number of different measures to control erosion. A division is often made between "mechanical protection" (terraces, drains, waterways, etc.) and "biological protection" (crop rotation, cover crops, etc.). Widening the scope of measures even further, Dudal (1981, p. 8) defines conservation as "... the promotion of optimum use of land in accordance with its capability so as to assure its maintenance and improvement." It is with this wider and more active interpretation of "conservation", that this book should be read.

The term "land improvement" will sometimes be used synonymously with "soil conservation", as the division of "improvement" and "maintenance" is one of choosing an arbitrary point of reference: maintaining current land productivity is an improvement upon the alternative of land degradation. In dry areas, water conservation is a crucial aspect of land improvement. However, this aspect is not important here. For brevity, the longer concept of "soil and water conservation" will therefore generally be referred to as only "soil conservation", or even "conservation" as the context should be clear.

Equipped with these key concepts, we are ready to pursue the question of the extent of land degradation.

2.1.2 Physical Assessments

There are a few global maps, and a large number of national maps with erosion data.[2] This section is confined to some of the most recent, global estimates.

A major study to map the land base globally was the "Land Resources for Future Populations Project" undertaken by FAO and cooperating agencies (FAO, 1984; Higgins et al, 1982). The project was based on 20 years of work and produced several detailed maps describing soils and agro-ecological zones. The purpose of the project was to highlight the question of the overall food production capacity of each and every country, considering soils, climate, technological level and land degradation. The susceptibility to erosion was estimated by calculating indices based on data on soil, slope, texture and vegetation cover. The FAO study projects a global loss of productivity of rain-fed cropland of 29 percent for the period 1975-2000, if present trends are allowed to continue. However, much of the degraded land has a secondary use as grassland supporting livestock. The net loss of productivity is therefore somewhat lower. The most serious losses are reported for Africa and Central America.

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2. A detailed review is available in Jansson (1982). She also critically examines the technical basis for these assessments.

An assessment of the global desertification was provided for the UN Conference on Desertification in 1977 (UNCOD, 1977). This is to some extent a re-statement of the earlier FAO estimates of land degradation. The UNCOD studies did not produce a world desertification map, but rather a desertification hazard map. Furthermore, it did not lead to a system of regular and consistent monitoring of land degradation in the arid regions of the world.

The UNCOD launched a global Plan of Action to Combat Desertification (PACD). One element of this was to follow up the development of desertification through questionnaires and study visits. The result of these efforts are reported in Mabbutt (1984) and commented further in Dregne (1984). Inadequate data made it impossible to make very specific national assessments, but broad generalizations as to regions are made. The new assessment in 1984 confirmed the seriousness of desertification, and pointed to increases in the areas and populations at risk. The "threatened area" was estimated at 4.5 billion ha, which constitutes 35 percent of the land surface of the Earth, with almost 20 percent (850 million) of the world's total human population. Of this area, the larger portion was said to be already "moderately desertified" and the rest in more severe conditions. The only areas of diminishing desertification were found to be Europe and North America (Mabbutt, 1984).[3] These estimates are still the most up-to-date ones available (Grainger, 1990).

Brown and Wolf (1984) project a global decline in available cropland per person of 19 percent between 1984 and 2000, and a decline in topsoil of 32 percent per person. Estimates are of course inexact, but the authors argue that this process will eventually undermine the world economy if not arrested.

The World Resources Institute states that global land degradation is believed to roughly remove crop land equal to the new areas added each year. The situation is particularly serious in sub-Saharan Africa, where the natural conditions for farming are uniquely inhospitable.

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3. However, see Nelson (1988) for a critical account of the Desertification Questionnaire, which was used as a basis for these estimates. Grainger (1990) contains another detailed discussion.

Although the area that can theoretically sustain rainfed agriculture greatly exceeds the one currently used, remaining lands suffer from fertility and other constraints. Arable soils generally have a low clay content, which makes the water absorption capacity low and the susceptibility to erosion high. (WRI, 1990).

One regional aspect of land degradation that has received particular attention is the popular notion of "the encroaching Sahara desert". This can be traced back to the writings of Lamprey (1975/1988). On the basis of a reconnaissance mission in 1975, he reported that the desert in Northern Sudan had advanced some 90-100 km since the latest documented observation 17 years ago. This led to the claim that the Sahara is expanding South at a rate of 5-6 km per year, a frightening image that easily captures the imagination of the public. This topic is returned to below.

The basic studies presented above have been the source of many re-statements and interpretations. The recent "Brundtland Report" (WCED, 1987b) has added to the alarming accounts. While this report received much attention from the media and the public, it is not based on original research regarding land degradation, and merely reiterates statements made previously by FAO and UNEP. The spirit of the many alarming reports of accelerating land degradation can be summarized by the following quote:

> "Humans are - out of desperation, ignorance, short-sightedness, or greed - destroying the basis of their own livelihood as they violate the limits of natural systems." Eckholm (1976, p. 18).

2.1.3 Monetary Assessments

Assessments of the financial or economic impacts of land degradation are very few at the global level, few at the national level and not very numerous at the local level. The latter show a poor coverage of developing countries. The poverty of monetary estimates are probably dependent on two basic factors. First, that relevant research has been compartmentalized and has basically become the domain of natural scientists. Few economists have

ventured into the field.[4] Second, such studies put high demands on long-term, qualified monitoring. The ensuing survey starts with the local level and continues via the national level to the global perspective.

Local Level Estimates

Estimates of the monetary costs of land degradation must be advanced in order to calculate the net value of conservation projects. The physical relationship between land degradation and development of crop yield over time is the cornerstone of monetary assessments.[5] However, the relationship between land degradation and production has not been adequately addressed:

> "... there is an extraordinary lack of quantitative data on the relations between erosion, plant production and financial returns.... In most situations, the conservationists are unable to say how much harvest a farmer will not lose by preventing erosion ..." (Shaxson, 1985, p. 669).

Similar statements abound in the literature,[6] but let us see what evidence is actually available. Stocking and Peake (1985) have made an extensive survey of available studies and identified 195 reports regarding erosion and its impact on crop yield. There is an extreme geographical concentration to the USA in the studies that are available. Australia and Europe account for most of the remaining observations, leaving only about one fifth of the studies with a developing country basis. Unfortunately, local level results cannot easily be extrapolated to make inferences about other climatic and soil environments which can underpin national and global assessments.

The impact of a unit of soil loss varies considerably depending on conditions. The correlation between yield

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4. More generally, it has been remarked that academic development economists have neglected the importance of environmental issues. Furthermore, economists concerned with environmental matters have usually focused on the problems of industrialized countries. (Dasgupta and Mäler, 1990).
5. The issue is discussed further in chapters 4 and 5.
6. See e.g. Miranowsky (1984), Stocking and Peake (1985), Walker (1982) and Williams (1985).

and erosion can be almost linear for thin soils or those with large reserves of weatherable minerals through the profile. However, it can be strongly exponential for soils with nutrients concentrated in the topsoil and sharp textural contrasts. Furthermore, no single factor explains the loss of yield, but the most important ones are nutrient status (nutrients, organic matter, pH), water availability (soil depth and retention capacity), and structural stability (bulk density influences root development).

The subject of micro-level assessments of erosion-productivity relationships, will be returned to in chapter 5, but this overview can meanwhile be summarized by the following pithy remark:

> "Erosion research has to date been producing results that are largely inapplicable to the making of sensible decisions about land use and future agriculture. We know a lot about rates of erosion but little about the effects of that erosion." (Stocking, 1985, p.10).

National Level Estimates

A few national studies are available regarding the economic impact of land degradation. There is some data available from Australia, Canada, Mali, Indonesia, USA and Zimbabwe.[7]

To our knowledge, there have been four macro-level studies of the costs of land degradation in **Australia** (Blyth and McCallum, 1987). The first two are based on estimates of the cost of controlling erosion. The other two also contain estimates of the benefits of control in terms of production otherwise lost. As usual, costs and benefits are reported as lump sums, per annum or as a total present value, not as functions of levels of erosion or erosion control. The most recent (1982) study reports the cost of salinity alone to be USD 64 million (1990 dollars)[8]. There have also been a number of studies

7. In chapter 3, an attempt to make a partial estimate for Lesotho is made.
8. Re-calculated using the average annual rate of inflation in 1980-1988 from World Bank (1990) and the average annual exchange rate in 1989 from IMF (1990).

of regional land degradation costs related to erosion in Australia (Sinden, 1990; Sinden et al, 1990; Upstill and Yapp, 1987) underscoring the seriousness of the situation.

The Science Council of **Canada** (1986, p .7) presents a national estimate of annual costs of land degradation of over USD 1.3 billion (1990). This corresponds to soil degradation costs of USD 20-25 (1990) per ha of agricultural land in Canada. Girt (1990) presents another set of estimates for the national on-farm annual cost of wind and water erosion, salinity, compaction and acidification, made by the Department of Agriculture in Canada. Summing up the various categories and re-calculating to USD (1990), we arrive at an estimate of some 0.9-1.1 billion as an annual, national on-farm cost.

Bishop and Allen (1989) studied soil erosion in **Mali** from the perspective of quantifying the national cost of on-site erosion in terms of crop losses. Soil loss in tons per hectare per year is used as a proxy for declining soil fertility. Estimates of soil losses are derived through the use of the USLE[9]. Estimates of yield are derived as an exponentially declining function of cumulative soil losses, using a decline coefficient from Lal's (1981) work in Nigeria. The equation is applied uniformly to all crops and to all regions.

The gross income loss in terms of yield foregone is deducted by savings of labour for weeding and harvesting. The area under each crop option is estimated. The result in terms of net income lost in the mapped regions (about 1/3 of Mali) is summarized and extrapolated to the entire country. As soil loss in any year will also affect crop yields in subsequent years, it is assumed that the same net value will also be lost in subsequent years. The authors use a 10 year time horizon,[10] because it is assumed that fallow will then begin and that land productivity will completely recover. The authors admit that this assumption may be too optimistic, which will bias the cost estimates downwards. The present value of

9. Universal Soil Loss Equation, see chapter 4 for an explanation.
10. This implies that this particular calculation is done for year 1 out of 10, as the time horizon for erosion in later years is shorter.

the income stream lost is calculated using a 10 percent rate.

The results show an average annual yield penalty of 2-10 percent in terms of net farm income foregone. Nationwide, the estimate is USD 5-19 million. If erosion in subsequent years before fallow is accounted for, the figure rises to USD 31-123 million, or 4-16 percent of agricultural GDP in Mali. Finally, the cost in terms of net income losses is compared to the costs of various conservation measures. It is concluded that several low-cost options, such as contour plowing, tied ridges rock lines, contour bunds, and grass strips are economically justified. However, more expensive measures, such as terracing, do not appear to be economically viable.

Repetto et al (1989) estimate the economic cost of soil erosion for Java (**Indonesia**). Their methodology is similar to the Mali case study, but less explicit in its assumptions. Single year (1985) costs are derived first, and then capitalized to obtain a total present value of future losses. This is done using an implicit rate of 10 percent and an infinite time horizon. Another assumption is that the net loss remains constant over future years. The result is an NPV of USD 484 million (USD 589 million, 1990). This compares to about 4 percent of the annual value of dryland farm output on Java. An attempt was made to empirically derive estimates of off-site erosion costs. This was reported to be an order of less magnitude than on-site productivity losses.

The major conclusion of the study is that the loss of productivity due to soil erosion is quite substantial, and an omitted item in the traditional national accounts. Thus, it underpins the main argument of that book: reform is needed to reflect the depreciation of natural resources stocks, when measuring national economic performance.

The **USA** is the only country in the world which has taken a systematic inventory of its topsoil (Brown and Wolf, 1984). This data set is known as the 1977 National Resources Inventory (NRI). To our knowledge, there are only three macro-level studies based on NRI. These are reported in Crosson and Stout (1983). They are not

strictly comparable, but qualitatively they can be discussed together.

The first was made by the US Department of Agriculture in 1980. It showed that continued cropland erosion (1977 level) for fifty years ahead would reduce national average crop yields at the end of the period by 8 percent. The second was made at the University of Minnesota. It concluded that continued erosion as in 1977 for 100 years ahead would diminish national yields by 5-10 percent. The third was made at Resources for the Future and concerned the Corn Belt. It reported that yields of corn and soybean had been reduced by 2-3 percent due to erosion between 1950 and 1980.

Several objections as to methodology and data gaps can always be raised. However, all three studies signal the same basic message:

> "They suggest that the productivity effects of 1977 erosion rates were, and are likely to continue to be, small, at least by comparison with the losses implied by some of the shriller cries of alarm about erosion presently heard." (Ibid., p. 4).

A later study by Colacicco et al (1989), using NRI data from 1982, resulted in similar estimates. Average future yields of maize, soybeans and cotton in the USA are forecasted to decline by an average of 4.6, 3.5 and 4.5 percent respectively, over the next 100 years if erosion continues at 1982 rates.

While the **relative** on-site impact of erosion in the USA thus appears limited, the **absolute** amount of damage is considerable. Colacicco et al (1989) have estimated that this amounts to USD 1.2 billion annually. Furthermore, the crop land's share of off-site damage costs due to soil erosion is quoted as approximately USD 2.2 billion. The total off-site damage is in the range of USD 3.2-13 billion per year. Ribaudo et al (1989) report a point estimate of total off-site damages from soil erosion in the USA of approximately USD 7 billion annually, as per 1983.

In **Zimbabwe**, the discovery by Stocking (1986) of previously neglected data on soil losses, and their

correlation with losses of nitrogen, phosphorus and organic carbon, made it possible to estimate the annual nutrient losses for various soils and farming systems. The national figures of nutrient losses were aggregated on the basis of area estimates of the respective management systems. Subsequently, the cost of replacing them by commercial fertilizers could be calculated.

The annual national financial cost of replacement (in 1990 dollars calculated from Stocking, 1986) of nitrogen and phosphorous was found to be USD 1.8 billion. The figure for arable land only was approximately 10 percent of that. Per ha, this implies USD 24-61 on arable lands and USD 12-97 on grazing land. However, one is left without a link between the loss of nutrients and loss of productive capacity. This makes it impossible to assess what the actual loss to Zimbabwe is, and therefore what the profitability of replacement would be.

Global Level Estimates

On a global scale, almost no monetary estimates are available. Global attempts to map erosion and erosion hazards have paid little attention to the economic aspects.

United Nations Environmental Programme (UNEP) has presented figures calculated on the basis of lost production from irrigated lands, rangelands and rainfed croplands. The global bill comes to an annual loss of USD 26 billion, (38 billion, 1990) of which USD 12 (18) billion pertain to developing countries (UNEP, 1980, p. 5 and Annex p. 66). The 26 billion dollar figure has been quoted at numerous instances, but never with a proper discussion on how it has been derived. Having been repeated enough times, it has become "a fact".[11]

11. This figure also appears in Grainger (1982, p. 9), ICIHI (1986, p. 41), Jepma et al (1987, p. 153), UNEP (1984, p. 45), UNEP and Commonwealth (1987, p. 4) and WCED (1987a, p. 69). Several references do not list any source for their claim, although some refer to UNEP. One UNEP source refers to H. Dregne, but without listing any publication. Dregne is Professor at the International Center for Arid and Semi-arid Land Studies, Lubbock, Texas, USA. In correspondence with the present author, he admits to the conjectural nature of this figure, and in fact, suggests a sizable downward revision of the estimate.

The United Nations Conference on Desertification (UNCOD) study uses less than one of its 448 pages to discuss the monetary costs and benefits of conservation. Its calculations concern arid and semi-arid lands only.[12] From a "group of expert consultants", a table is extracted that estimates the annual cost of corrective measures to USD 456 million (759 million, 1990) and the annual gross benefits (losses avoided) to more than USD 1 billion (1.7 billion, 1990). (UNCOD, p. 9).

Calculations on the basis of production actually lost are the most desirable from a theoretical point of view. But given the difficulty of firstly, knowing what the erosion rate is and secondly, relating this to decline in yields, we are often left with trying other methods. UNEP experts have estimated the cost of potential restoration of desertified land to USD 1.5 - 4 billion (2.2 - 5.9 billion, 1990) per year during 20 years. This only takes into account the degradation in countries with GDP/capita of less than USD 1000 (UNEP, 1980). These estimates are based on cost data from actual FAO and World Bank projects.

Voices of Qualified Optimism

Accounts of the extent of land degradation may seem quite depressing, but they are not uncontroversial. Assessments of a much more optimistic nature are available. The views discussed here are labeled "qualified optimism" because the optimism is partial. It concerns the land base and its potential for supporting a growing population. However, although technological "solutions" to land degradation may be available in theory, other obstacles, discussed below, may stand in the way for their realization. On that account, some of the "qualified optimists" may be rather pessimistic.

One type of disagreement concerns the interpretation of data on the physical extent of land degradation. A second type of disagreement concerns the ability of society to

12. "Arid" and "semi-arid" lands are defined as those receiving less than 250 mm and 250-500 mm of rainfall annually (UNEP, 1980, Annex p. 68). However, other definitions also occur in the literature.

adapt to increased population pressure and to introduce improved technology in agriculture.

Starting with the first kind of debate, the "encroaching Sahara" image is taken as one example. Recent studies using LANDSAT images and field visits from the 1970s and 1980s, have cast strong doubts about the validity of this image: "The impact of the Sahelian drought was short lasting followed by a fast land productivity recovery (Helldén, 1988, p. 11). Similar arguments can be found in a study of Central Sudan (Ahlcrona, 1988).[13] The issue remains controversial and cannot be resolved here.

Turning to the second kind of disagreement, there are more optimistic views on the supporting capacity of the land base. The FAO study quoted above is also the starting point for Revelle (1984). Interestingly enough, his conclusions are quite the opposite of the dismal ones above. Even with present-day technology, Africa can support a population of 1.5 billion people, he argues. This number is expected to be reached about 2025. With a high level of technology, the figure for agricultural supporting capacity is around 10 billion, Revelle claims. However, nothing is said about the national location of this agricultural potential and the assumptions regarding international trade.

In a similar manner, the editors of "The Resourceful Earth" conclude that "Land availability will not increasingly constrain world agriculture in coming decades." (Simon and Kahn, 1984, p. 2). On the contrary, the amount of arable land in the world is increasing, not decreasing, claims Simon (1981). Along similar lines, Beckerman (1974) argues that the problem is one of inefficient technology rather than one of a degrading land base. He foresees the counter-argument that more intensive cultivation will ruin the soil. He argues, however, that the soils of Western Europe have been farmed with increasing intensity for 2000 years, and they are still not exhausted. The differences in physical characteristics of the production systems are not discussed, however.

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13. See also Dregne and Tucker (1988) for a critical assessment of the discussion of desert expansion.

From a general perspective on agricultural development, Bauer (1981, pp. 49-50) argues that the real constraints on agricultural productivity are not a shortage of land, but "... lack of skills, ambition and energy, or social beliefs and customs adverse to economic achievement ...".

In summary, the major thrust of the arguments against an alarmist perception of land degradation is that there are social mechanisms of adaption that can handle this problem.

An Assessment of the Outlook on Land Degradation

With such a scanty data base and widely differing opinions being expressed, one may feel a bit confused as to the right course of action. We agree with Nelson (1988) that the problem of land degradation has been poorly described in that a false sense of certainty has often been conveyed in the literature.

Although deficient and sometimes obscurely presented, the best available data seem to indicate that substantial parts of the world, particularly the developing world, is suffering from excessive land degradation, with discouraging trends for the future. Some parts of the world have generally shown an impressive capability of adapting to higher population pressure by improving not only agriculturally, but technologically. This applies primarily to Europe, North America and parts of Asia. Technological advances - such as the high-yielding varieties of various cereals - have helped developing countries to boost their agricultural performance.[14]

To some extent, the camps of "optimists" and "pessimists" are not really arguing against each other. Most analysts would probably agree that technological performance has been impressive in parts of the world, and most would probably agree that the situation is desperate in others. The global outlook can then be dismantled into components of hope and of despair.

With respect to monetary assessments, there are several problems related to the monetary figures disseminated by

14. India is an important example. However, the long-term outlook in environmental terms is discouraging (CSE, 1985).

UNEP and followers. First, the lack of a sound micro-level basis for aggregating effects to the macro-level has been discussed. If one multiplies an uncertain figure per hectare with a vast amount of hectares - the result is an extremely large interval of uncertainty. This is not to say that estimates should not be made, but the assumptions and uncertainties must be spelled out in detail.

Second, these figures imply an average profitability that is unbelievably high for investment in conservation. The UNCOD figures quoted above imply an average internal rate of return (IRR) of 139 percent. The UNEP figures imply an average IRR of 478 percent.[15] One can only speculate about the fantastic rates of return at the margin of this gigantic package of investment opportunities. If such profitable projects were indeed available, substantial investments in conservation should be observed without any need to be subsidized, even when facing considerable credit constraints and transaction costs.

The third problem pertaining to the estimates is that they are expressed as lump-sums of total costs or benefits, per annum or as a present value. However, the design of rational macro scale land management programmes requires the marginal cost and marginal benefit functions to determine the optimum level of intervention. This goal is still quite distant.

Unless hampered by political interference, regular markets should be able to provide means for investments that are financially profitable. Investments that are economically, but not financially attractive, will require social support. In developing countries parts of this investment will have to come from aid sources. The total amount of foreign aid given by the OECD countries in 1988 was approximately USD 48 billion in nominal prices (World Bank, 1990). This shows that some of the estimates of the costs of land rehabilitation come to figures that are not too staggering, given that domestically mobilized resources should be able to cover

15. Compare the annual investment of USD 456 million with the annual benefit in terms of losses avoided of USD 1089 million (UNCOD) and the annual investment of USD 4.5 billion with the avoided losses of USD 26 billion per annum (UNEP).

a part of them. If the profitability is nearly as high as suggested, some re-direction of funds would be called for.

There is an evident need for persistent and qualified monitoring of land degradation in order to form the basis for better estimates of the physical extent of the problem. Modern satellite techniques can produce images of amazing quality at a reasonable cost and with high frequency over long periods. Coupled with ground checks, this can become an instrument for more solid physical assessments of the land degradation situation.[16]

Finally, and this is important, the physical estimates of land degradation need to be taken a step further in order to provide a sound basis for economic decisions on investment in land improvement.

16. See e.g. Chakela, Lundén and Strömquist (1986) and Helldén (1987) for empirical illustrations from Lesotho and Ethiopia respectively.

2.2 The Experience of Land Improvement Projects

Erosion is as old as land itself. The history of active efforts to combat erosion is also quite long, but documentation is scanty. Space does not permit any discussion of "indigenous methods" of soil conservation, some of which date quite far back in time. The concern here is with the modern attempts - mostly administered by colonial regimes or aid agencies - to promote sustainable agriculture through conservation. The bulk of this experience lies in the period after World War II. What then has come out of past efforts to promote land rehabilitation?

Evaluating the historical efforts to counter land degradation is very difficult given the scanty evidence available. When conservation is seen as a general moral obligation to the future there is little perceived need to monitor the achievements in social cost-benefit terms. To the extent that documentation has been attempted, the evidence is often discouraging: "... the struggle against desertification has failed to produce satisfactory results ..." (ICIHI, 1986, p. 11). There is very little written evidence of successful programmes and sizable projects. Most evaluations and comments on conservation policies indicate failure (Blaikie, 1985). IFAD summarizes the African experience thus: "... most conservation programmes so far attempted have been unsuccessful. For various reasons, structures and activities introduced are not maintained. Moreover, most programmes have been too expensive and too complex to be replicable." (IFAD, 1986, p. ii). Harrison provides similar evidence and calls the third chapter of his book The Greening of Africa: "Why things go wrong in Africa: the record of failure." (Harrison, 1987. p. 46).

An attempt to write the history of soil and water conservation in Southern and Eastern Africa (SADCC, 1987a) has provided a general picture of the policies pursued, but little quantitative information. The general picture is one of failing "command" approaches to conservation during colonial times. New ambitions and administrators have replaced the old ones, but results usually remain unclear.

There are, of course, examples of at least partial success of conservation efforts. Blaikie (1985), concludes from a review of policies of LDCs and some other countries, that only South Korea, the Republic of South Africa and parts of the People's Republic of China can lay any claim to a successful national policy. This evaluation is partially supported by ICIHI (1986), which also reports the South Korean example of re-afforestation as an outstanding example, and commends the Chinese shelterbelts. It goes on to briefly refer to cases of impressive conservation projects: tree planting in Algeria, Burkina Faso, Ethiopia, India, Nepal and Niger. Irrigation of drylands has been successful in Tunisia, as has reclamation of desertified areas in the Kara Kum Desert, USSR. The descriptions of "success stories" are unfortunately quite sketchy in general, and economic indicators are not used.

The Kenyan national soil conservation programme is widely held to be a success.[17] Its geographical scope appears to be impressive, the technique used is simple and labour intensive. It now has activities in almost all districts in Kenya (SADCC, 1987b). However, this "success story" is not based on comprehensive economic analysis, and what little such analysis have been carried out[18] is not entirely convincing, and certainly not sufficient to declare the entire programme a great success in economic terms.

It is rare to find examples of successful rangeland projects, although ICIHI (1986) claims to have found one in Syria. Most attempts to control grazing have failed, Grainger (1990) notes, and quotes a number of broad assessments to that effect. The situation is anecdotally but accurately captured by the following indirect quote from Brandström (1985, p. 41):

> "When I pleaded for someone to cite just one pastoral development project which had been even partially successful, so that we might learn from success if we refused to do so from failure, I was put down pretty sharply."

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17. See Brown and Wolf (1984), Cassen (1986), Harrison (1987), Hedfors (1981), Holmberg (1985) and SIDA (1982).
18. See chapter 4 regarding two examples from Kenya.

The Reasons for Failure or Success

What are the reasons for this frequent failure of conservation efforts to produce positive results? While the emphasis shifts between different sources, some key factors emerge. Some observers refer to factors more or less exogenous to the developing countries own scope of planning: unfavourable climatic conditions, international economic recession, declining export prices, debt repayment crisis, and so on. However, most observers would place the responsibility in the hands of national governments and supporting aid organizations. There has been a tendency to see land degradation as a "technical" problem and not to consider its proper socio-economic context. This means that the evident symptoms of land degradation have been attacked, but the underlying causes have not been dealt with: tree seedlings have been planted only to be grazed by goats utilizing the common property right of feeding on the range. In line with this approach, local participation has been neglected, and a top-down approach favoured. The result is often indifference, but sometimes outright hostility to conservation efforts. Not even the technical "solutions" have always been sound, as they have sometimes been replicas of text book models unsuited for local conditions. This has further discredited conservation ideas in the eyes of the local public.

There has also been a failure of the developing countries to incorporate the work against land degradation in their general development planning, and to give the matter sufficient high-level attention and financial allocations. To a varying degree among observers, the responsibility is also put on the shoulders of the international community and its aid agencies for the lack of learning from past failures and poor coordination of aid efforts.

Harrison's book "The Greening of Africa" was designed to be a success story write-up. The key to success is **participation**, concludes Harrison. He emphasizes that this must start already at the project design stage. The local population may see the problems quite differently from the visiting experts. "Let them define the problems as well as the solutions in cooperation with external experts", is the message. Participation must of course be

carried through to the actual implementation of the project. Local resources should be mobilized as far as possible. This keeps costs down and creates a feeling of identification with the project. The third aspect of popular participation is project management. The benefits of the project must be immediate enough and visible enough to engage local people in sustaining the momentum by themselves. Other key components of "the secrets of success" are, according to Harrison, flexibility, the quality of leadership on all levels involved, the use of low-risk investment and efficient spreading of information through market channels.

A final note is due on the criteria for evaluation. "Success" is often described in physical terms: kilometres of terraces constructed, number of trees planted, number of farmers involved etc. While these data are of interest, they should be regarded as input data to the actual evaluation. The simple - but often neglected - point made here, is that one ought to be more concerned with the resulting outputs; increases in the production of cereals, firewood, fruits and vegetables, etc. It is only then that one can proceed to value the result in financial and economic terms. This will be discussed in detail in chapters 4 and 5.

Re-directing the Efforts of Soil Conservation

It is promising that the understanding of land degradation as a socio-economic rather than only a physical process is now gaining ground. This realization is also reflected in renewed attempts at finding a viable strategy to promote sustainable use of land. Blaikie (1985), Hudson (1988) and IFAD (1986) provide examples of strategies based on popular participation and a holistic approach to conservation as part of general farming development efforts. The loss of productivity rather than loss of soil itself is featured as the problem. This approach will affect the messages conveyed to farmers, and extension advice in packages dealing with the entire farming system are advocated.

It is apparent that much of the well-intended efforts to combat land degradation have shown little success, and that new strategies are therefore needed. The basic causes of land degradation have not been efficiently

tackled, and the problem has too often been seen as a narrow technical one, rather than a socio-economic one. There are hopeful signs of a re-orientation, at least among some academics active in this field, although it takes considerable time for new ideas to penetrate government bureaucracies, educational institutions and extension services. However, merging soil conservation into a farming systems perspective is not enough, as this is only a sub-system of the wider context of markets and regulations affecting households. This leads us on to a wide and difficult field: the macro economics of land degradation. From that perspective, we are able to understand some of the more fundamental driving forces behind land degradation, and the reasons why micro scale efforts of land improvement have often failed.

2.3 The Driving Forces behind Land Degradation

Although the extent of land degradation globally is not well known, it is clearly an acute problem to some parts of the world. It is also clear from the previous section that past efforts have generally been unsuccessful in tackling this problem. This prompts a search for a more profound understanding of the problem. What mechanisms lie behind this degradation of the environment? Traditionally, the causes of land degradation are enumerated in physical categories: overpopulation, overcultivation, overgrazing, deforestation, unskilled irrigation and - to a varying extent - climatic factors (Nelson, 1988; Tolba, 1987). However, with the exception of climatic factors, these are physical manifestations of underlying imbalances, and leaves us with another set of questions as to why they occur.

It is sometimes debated to what extent the causes of land degradation are the result of human activity and to what extent natural factors are the culprits. Ahlcrona (1988, p. 13) argues that "If drought, natural erosion or natural disasters are the causes of the land transformation, then there is little we can do to counter these phenomena. If man is the cause, the land transformation is in most cases reversible." In similar terms, Dregne (1987, p. 9) argues that if drought is the cause, it becomes an "act of God" over which man has no control. If the cause is human actions, steps can be taken to control the problem.

However, the argument can be turned around; Natural causes, such as drought, can exhibit a cyclical pattern. Thus, strategies of flexible adjustments can be found, such as storage of water, irrigation from deep wells, temporary adjustments in crops, migration, etc., that can mitigate the periods of hardship. Other natural causes such as erosion from wind and water can in principle be effectively managed by humans. Natural disasters (landslides, flooding etc.) can be prevented by proper land use, and their impact diminished by early warning systems, flooding protection, afforestation etc. On the other hand, human factors, such as deforestation due to population growth, can be quite difficult to reverse. Whereas the countering of natural causes behind land degradation implies the mobilization of humans against "a

common enemy", the countering of human causes implies the mobilization of humans against their own perceived rationality. Which is the most difficult can only be verified in a particular situation.

What matters from an economic and financial point of view is the cost of reversing degradation as compared to the benefits of this development. No matter what caused situation X, we are interested in the costs and benefits of improving it to Y. The causes may of course influence the costs of achieving Y, but this then becomes the matter to be addressed directly. The conclusion is that the dichotomy between natural and human causes is a red herring. The perspective applied here will be somewhat different, and start from a traditional neoclassical perspective.

2.3.1 The "Benchmark Economy" and Market Failures

Our point of departure is the neoclassical model of a perfectly competitive market. This "bench-mark economy" is characterized by the fact that the resource allocation is Pareto efficient, i.e. that no one can achieve an increase in welfare without diminishing someone else's. This condition is achieved automatically in an equilibrium in a market economy, but only under certain quite restrictive conditions (Arrow, 1969). Informally[19], one can summarize the conditions as demanding that if:

(1) markets are universal;
(2) all consumers and producers behave competitively, and
(3) an equilibrium exists,

then this equilibrium will be Pareto efficient. **Market failures** can be defined as deviations from the Pareto optimal situation. (Ledyard, 1987). Thus, market failures concern both the results existing markets achieve, and the fact that some markets are non-existent.

Attention is restricted here to the market failures that contribute particularly to land degradation. From this perspective, externalities, public goods/"bads", lack of risk and futures markets appear particularly relevant.

19 A rigorous discussion on Pareto efficiency is given in Varian (1978).

More or less explicitly, the case for public intervention to combat land degradation generally rests on consideration of these points.

The concept of Pareto efficiency is not an adequate guide to the optimal organization of society, as it is quite compatible with gross inequity. The fact that efficient markets may produce an **income distribution** that is politically unacceptable is often taken as a cause for public intervention. Even so, there is a case to be made for a competitive price system. It can be shown that if (1) the household indifference maps and the firm production possibility sets are convex[20], and (2) markets are universal, then any desired Pareto-efficient allocation can be achieved as a competitive equilibrium by reallocation of resources among individuals. (Arrow, 1969).

If one takes the view of the Brundtland report that "Poverty is a major cause and effect of global environmental problems" (WCED, 1987b, p. 3), there is also a need to redress a skewed income distribution from a land degradation perspective.

Externalities

The following definition of an "externality" has been suggested by Baumol and Oates (1988, p. 17):

> "An externality is present whenever some individual's (say A's) utility or production relationships include real (that is, non-monetary) variables, whose values are chosen by others (persons, corporations, governments) without particular attention to the effects on A's welfare."

It is commonly added - although Baumol and Oates do not think this to be necessary - that the impacts described in the definition above are not accompanied by any monetary transaction. Externalities introduce a distortion between the private and the social perspective, and can explain why privately rational

20. As noted by Starrett (1972), this standard assumption may not hold in the presence of environmental externalities. This points to the need for a broad scope of analysis. See Dasgupta (1982) for a discussion.

individuals may produce socially disastrous results. The relevance of this concept to land degradation is clear. There are commonly unidirectional externalities from upstream logging, livestock herding or farming to downstream agricultural production. Within a common property management system there will also be reciprocal externalities between livestock herds.

The debate about externalities on common property resources has given rise to the "tragedy of the commons school", eloquently expressed in Garrett Hardin's seminal article in Science:

> "Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in the commons brings ruin to all." (Hardin, 1968, p. 1244).

The famous passage quoted above has also met strong challenges (Dasgupta, 1982). This debate will surface again under the heading of property rights definition and enforcement below.

The mere existence of externalities, however, is not sufficient as a case for government intervention, as decentralized bargaining may well be the solution:

> "The farmer whose crops are damaged by runoff from a higher field will find it profitable to offer a side payment to the unwitting tormentor sufficient to induce him to reduce the runoff appropriately." (Baumol and Oates, 1988, p. 10).[21]

The quote above captures the spirit of the famous Coase theorem. Coase (1960) claimed that if only property rights were clearly defined, resources would be used in an efficient way without any need for government intervention. Even more astonishing, the resulting allocation will be independent of the initial allocation of property rights. These propositions provoked a voluminous debate which will not be reviewed here, apart from a very brief statement of the main objections to the

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21. While Baumol and Oates provide this example, they go on to criticize its implicit assumptions and relevance for practical purposes.

relevance of the Coase "theorem" for practical management of environmental externalities. These points appear highly relevant also to the sub-case of land degradation. In essence, it has been pointed out that:[22]

(1) The Coase "theorem" concerns a "small number case" with no transaction costs. This is an improper characterization of actual environmental externalities which often involve large numbers of people and high transaction costs.

(2) With many actors involved, strategic behaviour may prevent an efficient solution to be reached. The actors have an incentive to understate their willingness to pay in a bargaining situation, hoping to "free ride" on a collective settlement. A bargaining situation also invites threats of inflicting "externalities"[23] on the opposing party.

(3) Property assignment actually matter for the final outcome. Willingness to pay often differs from willingness to accept payment.[24]

It is not difficult to relate the topic of land degradation to these points. First, upstream erosion will typically damage a large number of individuals' property downstream. Additions of livestock to a communal rangeland will affect all other livestock owners. With transaction costs for a bargaining solution mounting, collective action to coordinate the resolution of conflicting interest may well be efficient.

Second, individualized bargaining among farmers would monetarize social relationships, generally starting from an unequal situation where kinship, wealth, political connections and power would in fact determine the financial outcome.

Third, the willingness to pay (WTP) for erosion protection of the widowed farmer downstream is bound by

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22. See Baumol and Oates (1988), Fisher (1981) and Krutilla and Fisher (1985).
23. Quotation marks are used here to note that this particular use of the concept contradicts the definition given above.
24. Mitchell and Carson (1989) provide further discussion on this particular point.

her income, whereas her willingness to accept (WTA) damage compensation may not be. One aspect of this is that damage may not only be inflicted to current income (crops) but also to future income (terraces, houses, trees). In the absence of a perfect capital market, the downstream farmer will not be able to borrow against future income, and WTP for avoiding damage will be less than WTA. Furthermore, the subjective sense of loss is not necessarily entirely captured by the financial values.[25] With differences between WTP and WTA payment, the amount of erosion will not be the same if the downstream widow is given the right to claim compensation for erosion, as if she has to pay the upstream farmer for preventing erosion.

In summary, there are several good reasons why we do not observe simple Coasian bargaining among Third World farmers. This is not a "carte blanche" for government intervention in the presence of any and all externalities. Pareto-irrelevant externalities could exist also in a first-best situation (Buchanan and Stubblebine, 1962). However, the presence of externalities signal the **potential** of efficient intervention, subject to cost-benefit considerations. This matter will be returned to in chapters 4 and 5.

Public Goods and "Bads"

A "public good/bad" can be defined as a good (or a service) where consumption by individual A does not diminish the quantity of the public good available to individual B (Samuelson, 1954). This property is also known as non-rivalry in consumption. Common examples of public goods include clean air, defence, the judicial system, radio broadcasts and the control of pests. Samuelson derived an optimal condition showing that a pure public good should be produced to an extent where the marginal cost equals the **sum** of all individuals' marginal willingness to pay for its provision.

In an idealized world, individuals could bargain for the provision of public goods, each one paying an individual "price" amounting to exactly his own willingness to pay

25. This will be recognized by people who have been burglarized and who have received "full" financial compensation from their insurance company.

for its supply. The resulting equilibrium prices constitute a Lindahl equilibrium (Lindahl, 1919; Sandmo, 1987). The problem arises that, whereas the willingness to pay for private goods can be read from conventional markets[26], it is more complicated to estimate people's appreciation of public goods. In general, people can be suspected of having an interest in "free riding" by understating their real preferences and still consume the public good.

Research in the past two decades has made many economists more optimistic about obtaining reasonably reliable information from consumers about their willingness to pay for public goods. Telling the truth is both simple and in accordance with a social norm that is not entirely without public support. Considerable effort has been put into development of the contingent valuation methods (CVM). This entails constructing more or less hypothetical markets where people are invited to reveal their preferences.[27]

While research may be able to document at least the order of magnitude of the sum of people's willingness to pay for public goods, their provision through private supply is still problematic. It is commonly difficult to exclude non-payers from using the supply of a public good. To the extent that exclusion is established, the user fee may exceed the marginal cost of provision to the particular individual, which entails a loss of efficiency.

The concept of public goods is relevant in the context of land degradation on several accounts. The provision of information on land degradation and measures to counter it has a public good character. Land rehabilitation measures like policing of communal rangelands or communal soil conservation structures protecting all land in a catchment are other examples. A reasonable conclusion is that some form of collective action is warranted to arrange the provision of this type of public goods.

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26. This assumes they are not too distorted by political interference - see below.
27. See Freeman (1979), Hufschmidt et al (1983) and Mitchell and Carson (1989) for an overview.

Risk Markets

The perception of risk may affect how future costs and benefits of an action are transformed into present values. Society as a whole benefits from both risk-spreading (many people will share the burden of failure, each one risking little) and risk-pooling (many different projects - some work, some fail). Arrow and Lind (1970) argue that if the risks are borne by the government, risk-spreading and non-correlation with the general state of the economy implies that society should be risk-neutral when discounting future costs and benefits. In other words, no adjustment of the usual discount rate needs to be made.

It is commonly assumed, on the basis of considerable empirical evidence[28] that individuals are risk-averse. They may therefore apply a high personal rate of discount when considering investment options. This may render long-term investments, such as tree planting and terracing, financially unattractive. Given the precarious situation of most smallholder farmers, this tendency to weigh immediate impacts much higher than long-term effects is natural. The individual's discount rate can be assumed to be based on considerations of risk/uncertainty as well as present income level and future income prospects in general (Fisher, 1930).

If the farmer could insure himself against crop failures in bad years and pay a small premium as a fraction of the long run increased surplus, he would be willing to take the risks of investing in farm improvements, including soil conservation measures. Higher yields per hectare would also alleviate some of the pressure to clear marginal land for additional cultivation. However, such risk markets are usually not available in developing countries as a result of spontaneous market forces.

One reason is that transaction costs are high. Establishing contracts with a large number of perhaps illiterate peasants in often inaccessible areas and collecting their insurance premiums may be a considerable obstacle. There may also be an element of moral hazard,

28. See e.g. Antle (1987), Binswanger (1980, 1982) and Dillon and Scandizzo (1978) for evidence regarding farmers in developing countries.

i.e. the insurance may affect the individual's behaviour in an adverse way. The land-manager may neglect laborious maintenance of soil conservation structures or watering of fruit trees, but still claim full compensation for the resulting loss in crops. There could also be a problem of adverse selection in insurance markets. Only those who expect to gain from insuring themselves, given the fee level, will take out an insurance. Thus, there will be an automatic, adverse selection of individuals or groups who will be attracted by the availability of insurance.

The problem with moral hazard and adverse selection is not the risk itself due to imperfect information about the future. Rather, it is the asymmetric distribution of information among agents that causes difficulties (Arrow, 1969). If everyone had access to the same information, insurance companies would see through moral hazards and design differentiated insurance schemes to tackle adverse selection.

Futures Markets

A related problem is the insufficiency of markets relating future goods and services to values today. The lack of such markets will affect people's time horizon. This is often quoted as an obstacle in tree planting campaigns. If the individual land manager had an unambiguous right to the trees he plants and could sell this right to anyone (including the right of re-planting for future harvests), he could at any point in time realize the present value of even a very distant future benefit of the trees. The time horizon would then not be a perspective that differed in private and public decision-making - it would be infinite.

This is not how markets work in many developing countries. One reason is the lack of defined property rights or lack of respect for such when defined. Trees planted on communal grounds may be subject to decisions by the chief, and trees under private ownership may be subject to theft of fruit and wood. This makes future benefits uncertain and discourages investment. Another reason is, again, the transaction costs of making such contracts including the cost of making forecasts about the future demand and prices for fuel, tree growth, survival rates, etc.

As future generations are not around to state their willingness to pay for, among other things, investments in land rehabilitation, the task of "representing" their interests is often seen as the legitimate task of the government.

Private versus Social Rationality

In summary, we have explored some reasons why private rationality may differ from social in ways that affect land utilization and the degree of land degradation in society. The suspicion is often that these market failures induce an excessive amount of land degradation, which is taken to constitute a basis for social intervention. In fact, the basis for such intervention is rarely critically examined before projects and programmes are designed, funded and implemented.

A couple of points outside the proper domain of market failures should be added in this context. First, the "benchmark" economy does not provide us with a yardstick as to the desirable **income distribution**. However, the concern for improved income distribution is often taken as a basis for public intervention with markets. One may argue about the extent to which the distribution is actually brought about by "free markets" or because of other policy interventions. The main point is that such intervention is often **perceived** as necessary. In particular, one is often concerned about the fact that poor people are forced to degrade their environment simply in order to survive (WCED, 1987b).

Second, it would be naive to forget that public intervention may have its roots in considerations quite separate from the categories of inefficiencies discussed here. The public choice perspective on government will be returned to below.

2.3.2 Government Failures

The view of government in development theory has changed full circle from the uncritical dirigism of the 1950s to the current preoccupation with failures of state

intervention (Bardhan, 1988, 1990). As the World Bank (1988, p. 1) acidly remarks:

> "... the perception of government has shifted during the past decade; where government was once commonly seen as a catalyst of development, many now think it an obstacle."

Although all governments definitely cannot be treated as a homogeneous group, some failures are common enough to warrant our attention in this context.[29] The public choice school has contributed much to our understanding of the role of governments and its bureaucracy by consistently applying the analytical tools of neoclassical economics in a field previously left, for the most part, to political science.

A note on terminology is necessary here. Several terms are used in the literature to denote non-optimal government behaviour. The most common is "government failure(s)" (Datta-Chaudhuri, 1990; Krueger, 1990; Pearce, 1988; Stiglitz, 1988; Tietenberg, 1988). Other terms are "policy failures" (Bojö et al, 1990; Schramm and Warford 1989), "political failures" (Dixon et al, 1989), or "public failures" (Bardhan, 1988; Stiglitz, 1988).

One argument for attaching **failures** to "policy" (or "political") instead of "government" (or "public") is that the latter suggest a rather more fundamental problem; something inherent in the institution itself rather than a mistaken course of action or lack of action. It is also fair to assume that sometimes the problem is one of lack of information rather than institutional structure.

However, it must be acknowledged that many failures are derived from the fundamental problem that the government (political leaders and the bureaucracy) is not maximizing a **social** welfare function, but rather a more narrow

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29. As one long-time observer of Africa has rather sweepingly put it: "The trend for the state to lose its role as instrument of development is evident throughout sub-Saharan Africa. Instead of becoming more effective, the post-colonial state is in danger of becoming good for little except provision of boundless employment." (Hydén, 1983, p. xii).

function of self-interest. These are the "genuine government failures". In those cases, more information to government will not directly address the failures, but economic analysis may strengthen an enlightened opposition to detrimental policies.

In most cases, a sharp line of division between failures of "policy" and "government" is not possible to determine in practice, although the record of information absorption may provide some guidance. As the distinction is blurred, and because of the convention generally adopted to use "government failures" as the general concept, this jargon will be adopted here. However, we will not lose sight of the distinction between distortions based on lack of information and others based on clear-sighted sub-optimization.

The more precise delineation of government failures is still to be discussed. Krueger (1990) reflects on two possible definitions of government failures. Starting with a Pareto-optimal equilibrium, the previously noted market failures will introduce deviations. Given the existence of market failures, government failures could be defined in two different ways:

(1) The actions of government, and failures to act, which result in a less-than Pareto-optimal situation;

(2) Those actions of government that result in a situation which is inferior to no action.

Both definitions are problematic. The wider concept makes (a) all remaining market failures and (b) any increased deviation from Pareto-optimality, government failures. This is a very wide concept which seems to place an insurmountable task on the shoulders of government. The second definition has, according to Krueger (1990, p. 11), the problems that:

> "... first, there is no distinction made ... between government failures to provide essential public goods ... and government actions leading to greater private departures from the first best than would otherwise occur; and second, the counterfactual is empirically unobservable."

On the last two points there is reason to dissent. The more narrow definition differs from the wider in its exclusion of non-actions: laissez-faire becomes the benchmark, and the lack of government activity is ruled out from being a "failure". This is not satisfactory in our view. Second, Krueger's second objection the more narrow definition applies equally to the more general definition. While she leaves the definitional choice unresolved, she appears to use the wider definition later in her article.[30] This is also the choice made here, for two reasons. First, the border-line between action and non-action is arbitrary: is a decision not to act not an action? Second, there is no reason to believe a priori that the failure not to intervene is any less serious than the failure to intervene. This should be determined by empirical observation, not by conceptual exclusion.

The remaining difficulty is that the scope of the theme of government failures is enormous. A choice will have to be made as to what areas are of prime interest from the perspective of land degradation. The discussion in this section will deal with the broad areas of property rights, population, prices, international trade, taxes, political élites, public investment and environmental information, in order to **screen for failures** that could be important from a land degradation perspective.

Property Rights Definition and Enforcement

A fundamental issue related to land utilization both directly and indirectly concerns the way in which property rights in general are defined, enforced and distributed. The last point is often neglected, but appears particularly relevant here. It is generally recognized that very poor people will be forced to apply a myopic perspective. The divergence between private and soical rationality will be particularly pronounced in such cases, with soil "mining" as a consequence. Following Randall (1987) "non-attenuated property rights" should be:

30. "Government failure may have consisted as much in failing to provide the infrastructure in which government has a large comparative advantage as it has in providing poorly things in which it does not have a comparative advantage." (Krueger, 1990, p. 17).

- completely specified: including ownership rights and penalties for violation;

- exclusive: all costs and benefits of the exercise of property rights should accrue to the owner;

- transferable: rights can be sold to the highest bidder;

- completely enforced: rights not enforced lose their meaning.

An important function of property rights is to internalize externalities (Demsetz, 1967). There are many cases where property rights are technically quite possible to define, but this is not done for political or cultural reasons. Communal range lands and temporary access to crop land are important examples affecting land utilization. The reasons for not introducing individual property rights may be more or less strongly related to high transaction costs. Consider e.g. the problems of defining, enclosing and enforcing private patches of grazing land on a village's communally owned property.

The introduction of inappropriately designed property rights may actively promote environmental degradation. When property rights are automatically conferred on those who "develop" the land by clearing it from forest vegetation, this accelerates deforestation (Binswanger, 1989; Mahar, 1989; Southgate, 1988), which in turn may contribute to land degradation.

As for the "tragedy of the commons" proposition advanced by Hardin (1968), a number of arguments have been raised in opposition. Firstly, on the conceptual level, the discussion about property rights should not be pursued in terms of a dichotomy between "undefined" communal property and "well-defined" private property. There is an important distinction between "open-access resources" and "common property resources" (Ciriacy-Wantrup and Bishop, 1975). It is only the former that has no control structure for its management. The fact that something is held in common, does not preclude stringent rules for its use. This has been shown by as e.g. Dahlman (1980) and Wade (1987) with examples from the European medieval open field system and current India, respectively. Bromley and Cernea (1989) have argued that the "tragedy of the

commons" is more appropriately named a "tragedy of the open access".

Secondly, on the issue of whether common property regimes actually lead to degradation, this result has been questioned. Dasgupta (1982) has argued that freedom in the commons may bring ruin to none; the price of output may be insufficient to induce overstocking on rangeland e.g. Other observers, such as Livingstone (1986) and Sandford (1983) have also questioned the empirical evidence of rangeland degradation due to alleged overstocking. On this point, the case of Lesotho will be discussed in some detail in chapter 3.

Thirdly, a common policy conclusion with respect to the difficulties of managing common property, is that private owners would manage the resource more efficiently. Demsetz (1967) has made the general propositions that (1) private owners are better equipped to take into account the interests of future generations and that (2) the costs of negotiating over management issues are lower in a system of private ownership.

The first part of the argument is simply stated without supporting evidence, and is contradicted by Grainger (1990) and Sandford (1983), referring to the short-sighted, exploitative use of private rangeland in Australia and USA. It appears that neither communal nor private control guarantees that the land be used for long-run sustainability. Which system that takes future generations' interests best into account would require a more stringent comparison between alternative management systems operating under ceteris paribus conditions. "Soil mining" need not be irrational if the proceeds are invested in alternative sources of welfare for future generations.

The second part of Demsetz' argument appears valid only if the area is given and many managers are replaced by a single manager/owner. However, if a given area is split up into privatized parts that are ecologically interlinked, e.g. because of significant runoff or the need for rotational grazing, the difficulties of coordination would remain even in a system of private ownership.

If privatization of communal lands is not a satisfying answer, are there other options? Runge (1981) argues that overgrazing has its roots in an "assurance problem" between livestock owners, that can be solved by innovative institutional rules. However, introducing such rules for communal management from outside is seen as a second best solution by Runge, who puts much faith in local policing based on loss of reputation and fines. Examples of local institutions able to handle grazing, irrigation and other public services are given in Chopra and Kadekodi (1990) and Wade (1987). Wade goes on to address the general issue of conditions for successful collective resource management, and lists the following:

(1) Resources: a small and clearly defined area;
(2) Technology: the cost of exclusion technology is small;
(3) User/resource relationship; in-situ residency, vital importance of resource for survival and high user knowledge of its use;
(4) User characteristics: number of users small and group well-defined, relatively powerful beneficiaries;
(5) Existing institutions: well developed and based on mutual obligations;
(6) Noticeability; cheating should be noticeable;
(7) Relation to state; little interference if preferred.

This is a demanding list of conditions, all of which are unlikely to be well fulfilled in an actual situation. We will return to the issue of common property in the context of Lesotho in the next chapter.

The discussion has so far concerned the key issue of communal land utilization, mostly relevant for livestock management systems. Turning the attention to crop land, the degree of privatization of rights has usually proceeded a step further. Still, there exists a whole range of tenure arrangements from strictly defined and enforced private property rights to open-access crop farming on the frontier to wilderness. Sharecropping arrangements are also frequent in developing countries.[31]

31. There is an extensive literature on sharecropping and its implications for agricultural efficiency. See Ellis (1988) for a review.

The absence of a commercial market for land is sometimes seen as a healthy sign of long-term "security" of use right. However, it is important to note that this implies that the opportunity cost of maintaining the use rights is then less than under a freehold system. In the latter, there is always the option to sell the land to the highest bidder. If such transactions are prevented, it results in some land being held by households that are either unable or unwilling to use it productively. Furthermore, it eliminates land as an alternative to livestock as a store of wealth, with possibly serious implications for overstocking of the rangeland. (Low, 1986).

The implications of the absence of a land market for land degradation, however, are ambiguous. A financially more productive use of land may increase land degradation if farmers do not face the full cost of this. On the other hand, large land purchases by absentee landlords for the sake of prestige or inflation safe storage of wealth may result in land lying idle, perhaps with much better vegetation cover than previously. But this is not the end of the story, as the people displaced by this development will have to turn to other areas for their survival. These might be city slums or marginal, fragile agricultural areas, where new cultivation may bring about serious land degradation. The net impact can only be determined by empirical investigation.

It is logical to expect that temporary or insecure tenure will shorten the planning horizon and discourage long-term investments in e.g. soil conservation structures and tree planting. However, empirical data relating tenure system specifically to soil loss is difficult to come by. Lee (1980) found no significant differences between rates of erosion and tenure groups in a study from the USA. The case of Lesotho will be discussed in chapter 3.

In summary, property rights are rarely completely non-attenuated, but covers a spectrum of more or less sophisticated rules of resource management. A full set of property rights does not develop because of (1) political restrictions or (2) transaction costs. Common property should be distinguished from open access property. On the basis of economic theory, one should expect that the greater the degree of internalization of land degradation

impacts, the better land management should be from a social point of view. However, land degradation is known to occur under private as well as common or open access property, and the empirical support for statements on the relationship between land tenure and land degradation is very weak.

Population Policy

Population policies may refer to population distribution as well as to population growth. Uneven distribution of land holdings may e.g. contribute to marginal land degradation, where the poorer peasants have to carve out a meagre living from steep slopes and thin soils, often clearing forests in the process. Governments may have to undertake land reforms in order to alleviate some of the environmental pressure.

Turning to the issue of population growth and public policy, we are faced with three challenging questions before any statement about population policy failure can be made:

(1) What is the relationship between population growth and land degradation?

(2) If there is a positive relationship between population growth and land degradation, why should the government intervene? After all, people may prefer to have more children even when this has an environmental cost;

(3) If there is a case for government intervention in order to reduce population growth, is there any effective way of achieving this goal?

Firstly, in the long run, even with a sound distribution of the population on the land, rapid population growth will aggravate environmental pressure. Failure to limit a rapidly increasing population is often cited as a strong determinant of environmental degradation: "No single factor contributes more to environmental degradation in developing countries than rapid population growth." (World Bank, 1989, p. 6). The increasing population of most developing countries is the main cause behind the extension of crop land into unsuitable areas, with

shallow and infertile soil. The consequences are disastrous, on-site and off-site. Thus, Dixon et al, (1989, p. 45) conclude that: "In the long run, birth control programmes may be the most effective policy to halt land degradation."

This view is controversial. Boserup (1981) emphasizes the adaptability of agricultural systems under pressure of increasing population. Growing populations could be a problem or a blessing depending on the situation. The fate of a country is likely to depend on the ability of the ruling elite to organize society, or what Boserup calls the level of 'administrative technology'. Along similar lines, Simon (1981) argues that people are the ultimate resource, that will find new and ingenious ways to overcome short run scarcities. While we acknowledge that the general issue of population growth vs. economic growth remains a bone of contention (Blaikie and Brookfield, 1987), it appears evident that rapid population growth presents a severe challenge for institutional change, if land degradation is to be avoided. Especially, when property rights are poorly defined, as in much of Africa, markets will not respond well and the effect is likely to be increasing deterioration due to deforestation, overgrazing and overcultivation.

The increasing population forces a more labour-intensive production system to emerge. While this does not induce land degradation per definition, this is in fact often the case given prevailing techniques. A typical sequence of population induced changes has been summarized by Lundahl (1979, p. 204):

"Forest tracts are turned into pastures. Pastures have to bear land-intensive crops. Plots hitherto used for land-intensive crops are instead used for labour-intensive crops. For each successive step in the process, the exposure of the soil to wind and water increases, and with that the risk of erosion. Each year a portion of the soil is lost forever for productive purposes."

Moving on to the second question posed above, a case for government intervention has to be made before any charge of negligence can be made. What are the main arguments in favour of public population policies? Firstly, the social

cost of population growth exceeds the private. Some of the cost of raising additional children is carried by others through the overutilization of common property, education and health subsidies, and so on.

Secondly, the private markets undersupply family planning services. (Birdsall, 1988; World Bank, 1984). This argument appears more convincing when it relates to research and public information rather than supply of contraceptive devices, where private firms should be able to furnish necessary services. However, given other constraints (lack of education, transportation, etc.) which decrease effective demand for such services, public intervention may also be necessary in this case.

Turning to the third question: even if one accepts the proposition that rapid population growth in general presents an environmental problem, and that there is a need for government intervention, one may still be unconvinced that this is a matter that the government can effectively deal with. Government policy in relation to population growth is not simply a matter of handing out contraceptives. Policies regarding the status of women and especially their education, children's schooling, health care, marriage ages, children quotas, family taxation, family allowances, and so on, may affect decisions about having children more than narrowly conceived family planning programmes.

It is extremely difficult to isolate the impact that active government measures can have on population growth. However, existing evidence from both cross-country studies and in-country studies gives the impression that "... public support for family planning programs ... can lower fertility quickly" (World Bank, 1984, p. 107). Examples are quoted from Colombia, Costa Rica, India, Indonesia, Mexico and Thailand. Such programmes will of course be most powerful when they coincide with other socio-economic factors contributing to the desire for smaller families.

In summary, population growth will often aggravate land degradation, governments have a role to play in shaping population policy, and there are - although in a qualified sense - effective means of achieving a decline in population growth. Yet, many governments rank low in

terms of commitment and public spending for family planning (World Bank, 1984).

Price Policy

State intervention in agricultural pricing is often considerable, in developed as well as developing countries. The OECD has calculated that the net transfers from tax-payers to agriculture within member countries amounted to more than USD100 billion in 1988. This does not include transfers from consumers due to border policies, which amounted to about USD165 billion in 1988. (OECD, 1989). Trade policies are discussed further below.

The macro-economic policies of developing countries have often had an "urban bias" with a low share of investments[32] directed to agriculture and adverse intersectoral terms of trade (Lipton, 1981). No only is agriculture discriminated against through general macro-economic policies, but also through specific sector policies that tend to depress farmgate prices (World Bank, 1986).

There are two layers in this debate. The first concerns the extent to which prices matter for the level and mix of agricultural output. The second concerns what impact any price induced impact on production will have on land degradation.

Regarding the first issue, there is common agreement that low agricultural producer prices are a disincentive to production. To what extent supply responds to higher prices is more controversial. The data base for Africa is so poor that great caution must be exercised when analyzing agricultural production trends (Fones-Sundell, 1987). She concludes her review of a considerable number of empirical studies from various parts of Africa by stating that "... there is very little empirical evidence to support the contention that African farmers are price responsive (Ibid., p. 18). Prices can serve as an incentive only if a number of other factors are simultaneously favourable, such as weather, access to inputs, storage, transportation and so on.

32. Public investment is discussed separately below.

A different view is presented in a brief review of empirical evidence in World Bank (1986), which suggests that supply response in developing countries is not low. On a similar note, Eriksson (1991) concludes that a substantial positive supply response has been fairly conclusively established among Tanzanian farmers with respect to changes in the relative prices of crops. There are also indications that total agricultural supply responds to changes in agricultural terms of trade.

To the extent that the mix of crops and the level of total agricultural output responds to changes in relative prices, this may also be important for land degradation, which takes us to the second question raised above.

The World Bank Development Report (1986) notes that pricing policies may exacerbate erosion by inducing farmers to grow the "wrong" crops. Barrett (1989) has remarked that this view is based on the implicit assumption that farmers do not incorporate the full costs of erosion in their decision-making. If they do so in a way that reflect the real social cost, there is nothing inherently "wrong" about growing a more erosive crop if it yields a greater stream of net benefits. However, Barrett's argument is based on a number of conditions that are rarely fulfilled. The financial and economic valuation of increase erosion might very well differ because of differences in the time horizon considered, the discount rate used, and the extent to which off-site impacts are taken into account.

Price policies affect **directly** both the use of inputs and production of agricultural outputs. Some examples are:[33]

- too low royalties on harvesting of mature timber has set off "timber-booms" with a devastating impact on natural forests in many countries;

- price ceilings on firewood and charcoal or subsidized sales from government woodlots discourage the adoption of private agroforestry schemes and firewood plantations;

33. See Barbier (1987, 1989), Repetto (1987), Repetto and Gillis (1988), Southgate (1988), Warford (1987) and World Bank (1988).

- irrigation subsidies promoting low-return investments that have caused or aggravated flooding and salinization of soils;

There are other examples where the impact of a price change is more ambiguous. Repetto (1987) has argued that depressed agricultural prices lower the farmers' incentive to practice soil conservation. Lipton (1987) has advanced the opposite argument. Both impacts are in fact possible. A rise in prices on agricultural output may encourage investments in erosion control measures, but may also give an incentive to cropping of marginal land, thus causing deforestation and increasing erosion (Southgate and Pearce, 1988).

Barrett (1989) has shown that in a world with an agricultural production function with fixed labour and only soil depth and current soil loss due to cultivation as arguments, the steady state choice between soil loss now and soil loss later is not dependent on an unexpected permanent price change. The "Golden Rule of Soil Conservation" does not contain a price variable. Put differently, an increase in price will make it both more profitable to exploit soil now, and to save soil for later, the impacts balancing out. However, he goes on to note that if a non-soil input is added, such as fertilizer, there may be an indirect effect of a change in the price of an output. If, for instance, the yield response to fertilizer is better for less eroded soils than for more eroded, this complementarity might induce farmers to conserve more soil together with an increase in fertilizer use, made economic by the higher output price.

However, Barrett (1989) also notes that if the trade-off is not only one of soil loss now versus soil loss later, but one of soil conservation costs now versus future relative increases in yield, then a rise in output prices will induce more conservation investments. This is consistent with the analysis in Collins and Headley (1983), Gray (1913), McConnell (1983) and Miranowsky (1984). It seems that such models better resemble the actual conservation choice of most Third World farmers.

There are also **indirect** environmental effects of pricing interventions on non-agricultural markets. The price of

foreign currency is one example. The overvaluation of the Dominican Republic currency has discouraged the environmentally relatively beneficial production of coffee and citrus fruit for export (Veloz et al, 1985). Overvaluation of the domestic currency is a common feature of Third World economies. However, the effects of price policies are complex and can go in various directions. A devaluation provides incentive to cultivate an export crop, but this may be favourable from a land degradation point of view (as coffee vs corn in Haiti) or unfavourable (as groundnut cultivation vs livestock rearing on grazing land in the Sahel.[34]

Other kinds of common price interventions with indirect impact on land degradation and improvement concern the labour market, particularly minimum wages. To the extent that these wages are enforced, which is by no means always the case, they will diminish labour demand for e.g. soil conservation works.

Interventions in the capital markets are also common in developing countries. Interest rate regulation, subsidized loans and the establishment of formal banking channels to expand credit supply are some measures (Bell, 1988). To the extent that credit is targeted to specific crops - such as sugar in Indonesia (Barbier, 1989) - it may also have significant impact on land utilization due to crop substitution.

International Trade Policy

Opinions differ as to what weight should be given to international versus national policy failures. The general impact of international trade on economic development has been subject to an extensive debate between the "dependency school" (Blomström and Hettne, 1984) and neo-classical and other economists. This debate cannot be pursued here, but a few notes of principle will be made.

34. These examples are based on a given crop management regime. Repetto (1987) argues that most export crops are less erosion inducing than food crops. However, crop management is much more important than the type of crop grown (Hudson, 1986).

WCED (1987b) blames both the workings of the international system and national government failures for the environmental crisis, with some emphasis on the former. The emphasis is reversed in World Bank (1981, 1987). Trade restrictions that limit access to agricultural markets in the industrialized world discourage investments in agriculture in the developing world. However, barriers to trade are not likely to be major factors behind environmental degradation in the Third World.

Firstly, the effect of a liberalization would be limited for the countries most affected by the environmental crisis, namely sub-Saharan Africa. Reductions in agricultural tariff and non-tariff barriers would benefit Africa to a marginal extent. Other developing countries would more successfully occupy the increased markets. Furthermore, Africa already has preferential access to the EEC. (World Bank, 1981). Secondly, to the extent that there is a connection between trade liberalization and agricultural investments and production in the Third World, its impact on land degradation is ambiguous, as already discussed.

Tax Policy

Another economic policy instrument that influences land utilization is taxation. This type of consequence has often been neglected. Investment tax credits have encouraged large-scale exploitation of environmentally weak areas in Brazil (Mahar, 1989). Differential rates of taxation among commodities may strongly influence cropping patterns and land-use. Within the agricultural sector, many countries discriminate against export crops. In the case of Haiti, a raised export tax on coffee caused coffee trees to be replaced with staple crops such as maize. This increased erosion of steep lands (Lundahl, 1979). Lowering the export tax for certain commodities, such as tropical timber, may also have environmentally detrimental impacts. Thus, the environmental impact will have to be assessed case by case.

Income tax exemptions impact environmental management. In some countries, virtually all agricultural income is exempt from income tax. This tends to increase demand for land and can contribute to a rapid increase in the

conversion of forest to agricultural uses, as the case of Brazil shows (Binswanger, 1989). A similar point is raised by Perrings et al (1988) with respect to overstocking in Botswana.

Political Elites

Government failures could be effectively dealt with if the government maximized a benevolent social welfare function containing the welfare of all the nations' inhabitants as arguments. Public choice theory (Tullock, 1987) has given us a more realistic understanding of real governments, although much of it is written on the basis of the experience of industrialized market economies. The political realities in many countries plagued by an environmental crisis unfortunately renders theories about voting behaviour and the voluntary organization of interest groups irrelevant. However, the basic lessons about self-interested sub-optimization remains applicable also in a Third World context. To this, the particular features of historical heritage and cultural values must be added for a more complete understanding of the role of political élites.[35]

Turning to the particual issue of land degradation, there are many countries where the following observation would be appropriate:

> "Desertification is a low priority for politicians because the people who live in arid zones have little political power. Government want aid spent in cities, where the results benefit the nation's élite." (Grainger, 1982, p. 4)

Similarly, Lundahl (1979, p. 231) concludes a review of the serious erosion problem in Haiti by explaining the lack of government activity thus: "... erosion control does not yield any direct benefit to the group of politicians who happen to be in power."

Dixon et al (1989) note that groups struck by land degradation often represent communities that differ in important aspects, culturally, linguistically, tribally and so on, from the majority of the population, or at

35. See Hydén (1983) and Sandbrook (1985) for perspectives on Africa.

least from the ruling elite. This makes their political voice weak.

Another reason for the relative lack of interest in conservation programmes is that they rarely bring opportunities for personal advancement and financial enrichment for bureaucrats, in comparison with the issuing of import-export licenses, the handling of foreign business, and the control of state-controlled markets (Blaikie, 1985).[36] On the contrary, neglecting the interests of soil conservation and favouring exploitation interests may carry substantial rewards:

> "The existence of large resource rents from harvesting mature timber has attracted politicians as well as businessmen to the opportunities of immediate gain." (Repetto and Gillis 1988, p. 388).

Furthermore, environmental programmes bring out conflicts of interests with e.g. large cattle-owners, land-owners and forest contractors. These people may also be a part of, or associated with, the political leadership and its bureaucracy, which makes the task even more delicate. Job security and risk-minimization are most important considerations for many government employees. The lack of government implementation of carefully worded resolutions and laws may therefore have quite logical explanations.

The role of the élites is a delicate issue, often avoided in public documents on land degradation. Ambitious plans for change often fail to recognize that there are strong vested interests in the status quo. The political élites have a direct interest in maintaining and enhancing current positions, or lack the incentives to alienate other powerful groups. The difficulties continue all the way to the village level, where local élites benefiting from current "communal management" may block changes.

Public Investment

The misuse of public funds for unwise investment, such as excessive military spending and wasteful prestige

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36. The more general issue of Directly Unproductive Activities (DUP) has been summarized by Bhagwati (1982) and improved our understanding of the full cost of government regulations.

projects is a theme that is certainly not limited in relevance to Third World countries. However, the effects in terms of retarded economic growth and lack of resources to combat land degradation is one that is felt even more strongly by poor people with limited options to evade the impacts of a deteriorating environment.

Public investment is very closely connected to environmental degradation in the case of deforestation (Repetto and Gillis, 1988). Such investments - often with the support of an external donor agency (Shane, 1986) - have led to substantial intrusions in natural forests to make room for estate crops such as rubber, palm oil and cocoa. The more specific impact on land degradation, however, is very much dependent on how the new vegetation is managed. Large-scale infrastructure investments in mining, dams and roads have also resulted in the substantial destruction of forests.

The theme of misdirected public investments is elaborated by the "Palme Commission's" report on Common Security (1982). The report argues that military spending not only crowds out alternative investment, but also retards growth in general. Our reflection is that the impact on growth may or may not have negative environmental effects depending on the nature of alternative investments. It remains clear that military spending in developing countries amounts to almost as much as expenditure on education and health combined (World Bank, 1984, p. 150). There are good alternative uses for these resources in terms of environmental protection, including land rehabilitation.

Public Information and Democratic Decision-making

Government failures under the heading of information and decision-making takes many forms. The denial of freedom to publicize and criticize freely will among other things also put a lid on the vital debate about land management. Societies without free elections will prevent competing movements from capitalizing on the need to modify public policy in the interest of environmental improvements. Environmental mismanagement and neglect may not be publicized and openly discussed for fear of reprisals. The recent avalanche of environmental scandals in Eastern Europe bears testimony to the importance of this point.

Finally, the problems have been brought out into the open, and responsible solutions can be demanded.

The Brundtland report (WCED, 1987b) addresses this theme and notes that progress will be facilitated by recognizing:

- the right of individuals to have access to current information on the state of the environment;

- the right to participate in decision-making on activities with a significant effect on the environment;

- the right to legal remedies for those whose health or environment has been or may be seriously affected.

Therefore, democratic reform is also an issue of importance from an environmental perspective.

2.4 Summary and Conclusions

The **purposes** of this chapter are to define the problem of land degradation, assess its importance, and establish a macro level analytical framework to be applied in the next chapter.

Land degradation is commonly taken to mean a loss of land productivity, through processes such as erosion, wind blowing, salinization, waterlogging, depletion of nutrients, deterioration of soil structure, and pollution. However, the fact that we can observe land to decline in productivity is not necessarily in contradiction with rational, or even optimal behaviour. It is only when the rate of degradation is off the social welfare maximizing path that we can speak of "excessive land degradation" from an economic perspective.

On the physical extent of land degradation the evidence is patchy, and particularly scanty when it comes to developing countries. However, the most thorough estimates available, made by specialists on physical aspects of land degradation, do indicate a rough but severe magnitude of the extent of land degradation striking some of the world's very poorest groups.

Economic and financial estimates of production losses due to land degradation and/or costs of corrective measures are not numerous and fewer the more aggregate the scope of analysis. Estimates are often based on unreliable data and sometimes obscure assumptions. No figures are quoted here, as they would contribute more to the folklore about conservation than to rational debate. Some indicate that the resources required for conservation investments would in fact be within potential reach of a joint effort of developing country farmers, national governments and the international community of donors. It should be possible to mobilize considerable resources for financially profitable investments through regular markets, if these are allowed to operate freely.

It should be recalled that land degradation is only a subset of the problem of agricultural production, which in turn is a subset of the general goal of food security for a particular population. This opens a wide arena for

alternative measures to counter the negative influence of land degradation.

Land improvement programmes and projects are not often evaluated from an economic point of view to a degree where conclusions about their success or failure can be made. To the extent that such evaluations are available, they often indicate failure.

There are certainly examples of projects, and even national programmes of conservation that are considered successes. However, it is often unclear what criteria have been used for evaluation. Sometimes physical achievements in terms of the provisions of inputs are quoted as proof of success, without any consideration of resource cost.

The massive record of failure has prompted a search for a new soil conservation strategy. Key elements in this strategy are an emphasis on production rather than preservation, people's participation, and low-cost, labour intensive technology.

The dismal record of past soil conservation efforts has also inspired a search for the more fundamental causes behind land degradation. It is argued here that market failures, such as negative externalities, undersupply of public goods, lack of risk and futures markets contribute to the deviation between privately and socially optimal behaviour. Unless these distortions are dealt with, efforts to improve land management will remain partial and ineffective.

While there is a case for social intervention to deal with market failures, there is also a strong case for careful design of such intervention. This includes a removal of distortionary policies that promote land degradation or contribute to the lack of progress in land rehabilitation. We have seen that while government is a part of the solution to land degradation, it is also a part of the problem.

Policy areas regarding property rights, population growth and distribution, price regulation, international trade, taxation, the role of political élites, public investments and public information and decision-making

are screened here for their relations to land utilization. Thus, an analytical framework is established that can be applied to the case study on Lesotho in the next chapter.

REFERENCES

Ahlcrona, E., 1988: The Impact of Climate and Man on Land Transformation in Central Sudan. Applications of Remote Sensing. Ph.D. dissertation. Lund University Press. Lund.

Anderson, J.R. and Thampapillai, J., 1990: Soil Conservation in Developing Countries. Policy and Research Series 8. World Bank. Washington, D.C.

Antle, J.M., 1987: "Economic Estimation of Producers' Risk Attitudes", pp. 509-522 in American Journal of Agricultural Economics. Vol. 69. No. 3.

Arrow, K.J., 1969: "The Organization of Economic Activity: Issues Pertinent to the Choice of Market Versus Nonmarket Allocation", pp. 47-64 in The Analysis and Evaluation of Public Expenditure: The PPB System. Subcommittee on Economy in Government of the Joint Economic Committee, Congress of the United States. US Government Printing Office. Washington, D.C.

Arrow, K.J. and Lind, R.C., 1970: "Uncertainty and the Evaluation of Public Investments Decisions", pp. 364-378 in American Economic Review. Vol. 60.

Barbier, E. B., 1987: "Natural Resources Policy and Economic Framework", in Tarrant, J. et al. (ed.), Natural Resources and Environmental Management in Indonesia. USAID. Jakarta.

Barbier, E. B., 1989: Economics, Natural Resource Scarcity and Development. Conventional and Alternative Views. Earthscan. London.

Bardhan, P., 1988: "Alternative Approaches to Development Economics", pp. 40-71 in Chenery, H. and Srinivasan, T.N. (eds.), Handbook of Development Economics. Vol. 1. Elsevier Science Publishers B.V. North Holland.

Bardhan, P., 1990: "Symposium on the State and Economic Development", pp. 3-7 in Journal of Economic Perspectives. Vol. 4. No. 3.

Barrett, S., 1989: Optimal Soil Conservation and the Reform of Agricultural Pricing Policies. LEEC Paper 8. IIED/UCL. London Environmental Economics Centre.

Bell, C., 1988: "Credit Markets and Interlinked Transactions", pp. 763-830 in Chenery, H. and Srinivasan, T.N. (eds.), Handbook of Development Economics. Vol. 1. Elsevier Science Publishers. North Holland.

Bauer, P.T., 1981: Equality, the Third World and Economic Delusion. Methuen. London.

Baumol, W.J. and Oates , W.E., 1988: The Theory of Environmental Policy. Cambridge University Press. Cambridge.

Beckerman, W., 1974: In Defence of Economic Growth. Jonathan Cape. London.

Bhagwati, J., 1982: "Directly Unproductive Profit-Seeking Activities", pp. 988-1002 in Journal of Political Economy. Vol. 90.

Binswanger, H.P., 1980: "Attitudes Toward Risk: Experimental Measurement In Rural India", pp. 395-407 in American Journal of Agricultural Economics. Vol. 62. No. 1.

Binswanger, H.P., 1982: "Empirical Estimation and Use of Risk Preferences: Discussion", pp. 391-393 in American Journal of Agricultural Economics. Vol. 64. No. 2.

Binswanger, H.P., 1989: Brazilian Policies That Encourage Deforestation in the Amazon. Environment Department Working Paper No. 16. The World Bank. Washington, D.C.

Birdsall, N., 1988: "Economic Approaches to Population Growth", pp. 477-542 in Chenery, H. and Srinivasan, T.N. (eds.), Handbook of Development Economics. Vol 1. Elsevier Science Publishers B.V. North Holland.

Bishop, J. and Allen, J., 1989: The On-Site Costs of Soil Erosion in Mali. Environment Working Paper No. 21. The World Bank. Washington, D.C.

Blaikie, P., 1985: The Political Economy of Soil Erosion in Developing Countries. Longman. London.

Blaikie, P. and Brookfield, H. (eds.), 1987: Land Degradation and Society. Methuen. London.

Blomström, M. and Hettne, B., 1984: Development Theory in Transition. The Dependency Debate and Beyond: Third World Responses. Zed Books Ltd. London.

Blyth, M. and McCallum, A., 1987: "Onsite Costs of Land Degradation in Agriculture and Forestry," pp. 79-98 in Chisholm, A. and Dumsday, R. (eds.), Land Degradation. Problems and Policies. Cambridge University Press. Cambridge.

Bojö, J., 1988: "Sustainable Use of Land in Developing Countries", pp. 39-51 in Perspectives of Sustainable Development. Some Critical Issues Related to the Brundtland Report. Stockholm Studies in Natural Resource Management, No. 1. Stockholm Group for Studies on Natural Resources Management.

Bojö, J., Mäler, K-G. and Unemo, L., 1990: Environment and Development: An Economic Approach. Kluwer Academic Publishers. Dordrecht, The Netherlands.

Bojö, J., 1991: "Economics and Land Degradation", pp 75-79 in Ambio: Special Issue: Environmental Economics. Vol. 20, No. 2. Royal Swedish Academy of Sciences. Stockholm.

Boserup, E., 1981: Population and Technology. Basil Blackwell. Oxford.

Brandström, P., 1985: "Do We Really Learn from Experience," pp. 41-56 in Hjort, A. (ed.), Land Management and Survival. Scandinavian Institute of African Studies. Uppsala.

Bromley, D.W. and Cernea, M.M., 1989: The Management of Common Property Natural Resources. Some Conceptual and Operational Fallacies. World Bank Discussion Papers. No. 57.

Brown, L.R. and Wolf, E.C., 1984: Soil Erosion: Quiet Crisis in the World Economy. Worldwatch Paper 60.

Buchanan, J.M. and Stubblebine, W.C., 1962: "Externality", pp. 371-384, in Economica. Vol. 29.

Cassen, R. and associates, 1986: Does Aid Work?. Clarendon Press. Oxford.

Chakela, Q., Lundén, B. and Strömquist, L. (eds.), 1986: Sediment Sources, Sediment Residence Time and Sediment Transfer - Case Studies of Soil Erosion in the Lesotho Lowlands. UNGI Rapport No. 64. Department of Physical Geography, University of Uppsala. Uppsala.

Chopra, K. and Kadekodi, G.K., 1990: Participatory Institutions: The Context of Common and Private Property Resources. Institute of Economic Growth. University Enclave. Delhi.

Ciriacy-Wantrup, S.V. and Bishop, R.C., 1975: "'Common Property' as a Concept in Natural Resources Policy", pp. 713-727 in Natural Resources Journal. Vol. 15.

Clark, C.W., 1973: "Profit Maximization and the Extinction of Animal Species", pp. 950-961 in Journal of Political Economy. Vol. 81.

Coase, R.H., 1960: "The Problem of Social Cost", pp. 1-44 in The Journal of Law and Economics. Volume 3. October 1960.

Colacicco, D. et al., 1989: "Economic Damage from Soil Erosion", pp. 35-39 in Journal of Soil and Water Conservation.

Collins, R.A. and Headley, J.C., 1983: "Optimal Investment to Reduce the Decay Rate of an Income Stream: The Case of Soil Conservation", pp. 60-71 in Journal of Environmental Economics and Management. Vol. 10.

Cooper, C., 1981: Economic Evaluation and the Environment. Hodder and Stoughton. London.

Crosson, P.R. with Stout, A.T., 1983: Productivity Effects of Cropland Erosion in the United States. Resources for the Future. Washington, D.C.

CSE (Center for Science and Environment), 1985: The State of India's Environment 1984-85. The Second Citizen's Report. New Delhi.

Dahlman, C., 1980: The Open Field System and Beyond. A Property Rights Analysis of an Economic Institution. Cambridge University Press. Cambridge.

Dasgupta, P., 1982: The Control of Resources. Basil Blackwell. Oxford.

Dasgupta, P. and Mäler, K-G., 1990: The Environment and Emerging Development Issues. Paper presented at the World Bank's Annual Bank Conference on Development Economics, 26-27 April.

Datta-Chaudhuri, M., 1990: "Market Failure and Government Failure", pp. 25-39 in Journal of Economic Perspectives. Vol. 4. No. 3.

Demsetz, H., 1967: "Toward a Theory of Property Rights", pp. 347-359 in American Economic Review. Vol. 57.

Dillon, J.L. and Scandizzo, P.L., 1978: "Risk Attitudes of Subsistence Farmers in Northeast Brazil: A Sampling Approach", pp. 425-435 in American Journal of Agricultural Economics. Vol. 60. No. 3.

Dixon, J.A., James, D.E. and Sherman, P.B., 1989: The Economics of Dryland Management. Earthscan. London.

Dregne, H., 1984: "Combating Desertification: Evaluation in Progress", pp. 115-121 in Environmental Conservation. Vol. 11. No. 2. The Foundation for Environmental Conservation. Switzerland.

Dregne, H., 1987: "Reflections on the PACD", pp. 8-11 in Desertification Control Bulletin. November. UNEP. Nairobi.

Dregne, H.E. and Tucker, C.J., 1988: "Desert Encroachment", pp. 16-19 in Desertification Control Bulletin. No. 16.

Dudal, R., 1981: "An Evaluation of Conservation Needs", pp. 3-12 in Morgan, R.P.C. (ed.), Soil Conservation. Problems and Prospects. John Wiley. Chichester.

Eckholm, E.P., 1976: Losing Ground. Environmental Stress and World Food Prospects. Worldwatch Institute and Pergamon Press. Oxford.

Ellis, F., 1988: Peasant Economics. Farm Households and Agrarian Development. Cambridge University Press. Cambridge.

Encyclopaedia Britannica, 1979. Micropaedia, Volume 3. Encyclopaedia Britannica Inc. Chicago.

Eriksson, G., 1991: The Analysis of Peasant Supply Response to Price Incentives. Theoretical Development and Empirical Examination. Department of International Economics and Geography. Minor Field Study Series. No. 22. Stockholm School of Economics. Stockholm.

FAO, 1984: Land, Food and People. FAO Economic and Social Development Series No. 30. Based on the FAO/UNFPA/IIASA report "Potential Population-supporting Capacities of Lands in the Developing World." FAO. Rome.

Fisher, A.C., 1981: Resource and Environmental Economics. Cambridge University Press. Cambridge.

Fisher, I.,1930: The Theory of Interest. The Macmillan Company. New York. (Reprinted 1970. Augustus M. Kelley Publishers. New York.)

Fones-Sundell, M., 1987: Role of Price Policy in Stimulating Agricultural Production in Africa. Issue Paper no. 2. Swedish University of Agricultural Sciences. International Rural Development Centre. Uppsala.

Freeman, A.M., 1979: The Benefits of Environmental Improvement. Theory and Practice. Johns Hopkins University Press. Baltimore and London.

Girt, J., 1990: "Land Degradation Costs in Canada: A Recent Assessment", pp. 294-303 in Dixon, E.J., James, D.E. and Sherman, P.B. (eds.), Dryland Management: Economic Case Studies. Earthscan. London.

Glantz, M.H. and Orlovsky, N.S., 1986: Desertification: Anatomy of a Complex Environmental Process", pp. 213-229 in Dahlberg, K.A. and Bennett, J.W (eds.), Natural Resources and People. Conceptual Issues in Interdisciplinary Research. Westview Special Studies. Boulder and London.

Grainger, A., 1982: Desertification. How People Make Deserts, How People Can Stop and Why They Don't.

Earthscan Paperback published by the International Institute for Environment and Development. London.

Grainger, A., 1990: The Threatening Desert. Controlling Desertification. Earthscan. London.

Gray, L.C., 1913: "The Economic Possibilities of Conservation", pp. 497-519 in Quarterly Journal of Economics. Vol. 27.

Hardin, G., 1968: "The Tragedy of the Commons", pp. 1243-1248 in Science. No. 162. American Association for the Advancement of Science. (Also reprinted in Hardin and Baden, 1977).

Hardin, G. and Baden, J., 1977: Managing the Commons. Freeman & Co. San Francisco.

Harrison, P., 1987: The Greening of Africa. International Institute for Environment and Development and Earthscan. London.

Hedfors, L., 1981: Evaluation and Economic Appraisal of Soil Conservation in a Pilot Area. Ministry of Agriculture. Nairobi. Kenya.

Helldén, U., 1987: An Assessment of Woody Biomass, Community Forests, Land Use and Soil Erosion in Ethiopia. A Feasibility Study on the Use of Remote Sensing and GIS-analysis for Planning Purposes in Developing Countries. Final Report. Department of Physical Geography, University of Lund and Swedforest Consulting AB.

Helldén, U., 1988: "Desertification Monitoring: is the Desert Encroaching?", pp. 8-12 in Desertification Control Bulletin. No. 17. UNEP. Nairobi.

Higgins, G.M., Kassam, A.H., Naiken, L., Fischer, G. and Shah, M.M., 1982: Potential Population Supporting Capacities of Lands in the Developing World. Technical Report of Project INT/75/P13, 'Land Resources for Populations of the Future'. FAO, IIASA and UNFPA. Rome.

Holmberg, G., 1985: An Economic Evaluation of Soil Conservation in Kalia Sub-Location, Kitui District. Ministry of Agriculture and Livestock Development. Nairobi.

Hudson, N., 1986: Soil Conservation. Batsford Ltd. London.

Hudson, N., 1988: Soil Conservation Strategies for the Future. Paper presented at the 5th International Soil Conservation Conference, January 18-29, 1988. Bangkok.

Hufschmidt, M.M., James, D.E., Meister, A.D., Bower, B.T. and Dixon, J.A., 1983: Environment, Natural Systems and

Development. An Economic Valuation Guide. Johns Hopkins. Baltimore and London.

Hydén, G., 1983: No Shortcuts to Progress. African Development Management in Perspective. Heinemann. London.

ICIHI (Independent Commission on International Humanitarian Issues), 1986: The Encroaching Desert. The Consequences of Human Failure. Zed Books Ltd. London.

IFAD (International Fund for Agricultural Development), 1986: Soil and Water Conservation in Sub-Saharan Africa. Issues and Options. Prepared by Centre for Development Cooperation Services. Free University. Amsterdam.

IMF, 1990: International Financial Statistics Yearbook 1990. Washington, D.C.

Independent Commission on Disarmament and Security Issues under the Chairmanship of Olof Palme, 1982: Common Security. A Programme for Disarmament. Pan, World Affairs. London.

Jansson, M.B., 1982: Land Erosion by Water in Different Climates. UNGI Report No. 57. Uppsala University, Department of Physical Geography. Uppsala.

Jepma, C.J., Gigengack, A.R. and MacRae, D., 1987: Global Damage Costs of Dryland Degradation. Paper presented at the African Workshop of the Economics of Dryland Management Workshop, Nairobi, Kenya, January 1987. University of Groningen, The Netherlands and Commonwealth Department of Arts, Heritage and Environment, Australia. Mimeo.

Kiker, C. and Lynne, G., 1986: "An Economic Model of Soil Conservation: Comment", pp. 739-742 in American Journal of Agricultural Economics. Vol. 68. No. 3.

Krueger, A.O., 1990: "Government Failures in Development", pp. 9-23 in Journal of Economic Perspectives. Vol. 4. No. 3.

Krutilla, J.V. and Fisher, A.C., 1985: The Economics of Natural Environments. Studies in the Valuation of Commodity and Amenity Resources. Resources for the Future. Washington, D.C.

Lal, R., 1981: "Soil Erosion Problems on Alfisols in Western Nigeria, VI. Effects of Erosion on Experimental Plots.", pp. 215-230 in Geoderma. Vol 25.

Lamprey, H.F., 1975/1988: "Report on the Desert Encroachment Reconnaissance in Northern Sudan: 21 October to 10 November 1975", pp. 1-7 in Desertification Control Bulletin. No. 17. UNEP. Nairobi.

Larson, B.A. and Bromley, D.W., 1990: "Property Rights, Externalities, and Resource Degradation. Locating the Tragedy", pp. 235-262 in Journal of Development Economics. Vol. 33.

Ledyard, J.O., 1987: "Market Failure", pp. 326-329 in Eatwell, J., Milgate M. and Newman P. (eds.), The New Palgrave. A Dictionary of Economics. Macmillan Ltd. London.

Lee, L.K., 1980: "The Impact of Landownership Factors on Soil Conservation", pp. 1070-1076 in American Journal of Agricultural Economics. Vol. 62

Lindahl, E., 1919: "Just Taxation", pp. 168-176 in Musgrave, R.A. and Peacock, A.T. (eds.), 1967: Classics in the Theory of Finance. Macmillan. London.

Lipton, M., 1981: "Why Poor People Stay Poor", in Hariss, J. (ed.), 1982: Rural Development. Theories of Peasant Economy and Agrarian Change. Hutchinson University Library. London.

Lipton, M., 1987: "Limits of Price Policy for Agriculture: Which Way for the World Bank?", pp. 197-215 in Development Policy Review. Vol. 5.

Livingstone, I., 1986: "The Common Property Problem and Pastoralist Economic Behaviour", pp. 5-19 in Journal of Development Studies. Vol. 23. No. 1.

Low, A., 1986: Agricultural Development in Southern Africa. Farm Household-Economics and the Food Crisis. James Currey. London.

Lundahl, M., 1979: Peasants and Poverty: A Study of Haiti. Croom Helm. London.

Mabbutt, J.A., 1984: "A New Global Assessment of the Status and Trends of Desertification", pp. 103-113 in Environmental Conservation. Vol. 11. No. 2. The Foundation for Environmental Conservation. Switzerland.

Mahar, D.J., 1989: Government Policies and Deforestation in Brazil's Amazon Region. World Bank. Washington, D.C.

McConnell, K.E., 1983: "An Economic Model of Soil Conservation", pp. 83-89 in American Journal of Agricultural Economics. Vol. 65. No. 1.

Miranowski, J.A., 1984: "Impacts of Productivity Loss on Crop Production and Management in a Dynamic Economic Model", pp. 61-71 in American Journal of Agricultural Economics. Vol. 66. No. 1.

Mitchell, R.C. and Carson, R.T., 1989: Using Surveys to Value Public Goods. The Contingent Valuation Method. Resources for the Future. Washington, D.C.

Morgan, R.P.C., 1979: Soil Erosion. Topics in Applied Geography. Longman. London and New York.

Nelson, R., 1988: Dryland Management: The "Desertification Problem". World Bank, Environment Department Working Paper No. 8. Washington, D.C.

OECD, 1989: Surveillance of Structural Policies. Report by the Economic Policy Committee. OECD. Paris.

Pearce, D., 1988: "The Sustainable Use of Natural Resources in Developing Countries", pp. 102-117 in Turner, R.K. (ed.), Sustainable Environmental Management. Principles and Practice. Belhaven Press. London.

Perrings, C., 1989: "An Optimal Path to Extinction? Poverty and Resource Degradation in the Open Agrarian Economy", pp. 1-24 in Journal of Development Economics. Vol. 30.

Perrings, C., Opschoor, H., Arntzen, J., Gilbert, A., and Pearce, D., 1988: Economics for Sustainable Development. Botswana: A Case Study. Gaborone.

Randall, A., 1987: Resource Economics. An Economic Approach to Natural Resource and Environmental Policy. Second edition. John Wiley & Son. New York.

Repetto, R., 1987: "Economic Incentives for Sustainable Production", pp. 44-59 in The Annals of Regional Science. Vol 21. No. 3.

Repetto, R. and Gillis, M. (eds.), 1988: Public Policies and the Misuse of Forest Resources. Cambridge University Press. Cambridge.

Repetto, R., Magrath, W., Wells, M., Beer, C. and Rossini, F., 1989: Wasting Assets. Natural Resources in the National Income Accounts. World Resources Institute. Washington, D.C.

Revelle, R., 1984: "The World Supply of Agricultural Land", pp. 184-201 in Simon, J.L. and Kahn, H. (eds.), The Global Possible. A Response to Global 2000. Basil Blackwell. Oxford and New York.

Reynolds, N., 1988: Communal Land Management. Swedforest Consulting AB. Danderyd, Sweden.

Ribaudo, M.O. et al., 1989: "The Economic Efficiency of Voluntary Soil Conservation Programs", pp. 40-43 in Journal of Soil and Water Conservation.

Runge, C.F., 1981: "Common Property Externalities: Isolation, Assurance, and Resource Depletion in a Traditional Grazing Context", pp. 505-606 in American Journal of Agricultural Economics.

SADCC, 1987a: History of Soil Conservation in the SADCC Region. Coordination Unit for Soil and Water Conservation and Land Utilization Programme. Report No. 8. Maseru, Lesotho.

SADCC, 1987b: People's Participation in Soil and Water Conservation. Coordination Unit for Soil and Water Conservation and Land Utilization Programme. Report No. 10. Maseru, Lesotho.

Samuelson, P.A., 1954: "The Pure Theory of Public Expenditure", pp. 387-389 in Review of Economics and Statistics. Vol. 36.

Sandbrook, R., 1985: The Politics of Africa's Economic Stagnation. Cambridge University Press. Cambridge.

Sandford, S., 1983: Management of Pastoral Development in the Third World. John Wiley & Sons. Chichester.

Sandmo, A., 1987: "Public Goods", pp. 1061-1066 in Eatwell, J., Milgate, M. and Newman, P., (eds.), The New Palgrave. A Dictionary of Economics. Macmillan Press Ltd. London.

Schramm, G. and Warford, J.J. (eds.), 1989: Environmental Management and Economic Development. Johns Hopkins University Press. Baltimore and London.

Science Council of Canada, 1986: A Growing Concern: Soil Degradation in Canada. Council Statement. Ottawa.

Shaxson, T.F., 1985: "Erosion, Economics, Subsistence and Psychology", in El-Swaify et al (eds.), Soil Erosion and Conservation. Soil Conservation Society of America. Ankeny, Iowa.

Shane, D.R., 1986: Hoofprints on the Forest. Cattle Ranching and the Destruction of Latin America's Tropical Forests. Institute for the Study of Human Issues. Philadelphia.

SIDA, 1982. Markvård i Kenya. Bistånd Utvärderat no 1/82. Stockholm.

Simon, J., 1981. The Ultimate Resource. Martin Robertson. Oxford.

Simon, J.L. and Kahn H. (eds.), 1984: The Global Possible. A Response to Global 2000. Basil Blackwell. Oxford and New York.

Sinden, J.A., 1990: "The Costs of Soil Degradation on the Northwest Slopes of New South Wales, Australia", pp. 282-293 in Dixon, J.A., James, D.E. and Sherman, P. (eds.), Dryland Management: Economic Case Studies. Earthscan. London.

Sinden, J.A., Sutas, A.R. and Yapp, T.P., 1990: "Damage Costs of Land Degradation: An Australian Perspective", pp. 282-293 in Dixon, J.A., James, D.E. and Sherman, P. (eds.), Dryland Management: Economic Case Studies. Earthscan. London.

Southgate, D., 1988: The Economics of Land Degradation in the Third World. The World Bank, Environment Department Working Paper No. 2. Washington, D.C.

Southgate, D. and Pearce, D., 1988: Agricultural Colonization and Environmental Degradation in Frontier Developing Economies. Environment Department Working Paper No. 9. The World Bank. Washington, D.C.

Starrett, D.A., 1972: "Fundamental Nonconvexities in the Theory of Externalities", pp. 180-199 in Journal of Economic Theory. Vol 4.

Stiglitz, 1988: "Economic Organization, Information, and Development", Chapter 5, pp. 93-160 in Chenery, H. and Srinivasan, T.N. (eds.), Handbook of Development Economics. Vol 1. Elsevier Science Publishers B.V. North Holland.

Stocking, M., 1985: Erosion-Induced Loss in Soil Productivity. A Research Design. FAO. Rome.

Stocking, M., 1986: The Cost of Soil Erosion in Zimbabwe in Terms of the Loss of Three Major Nutrients. Consultant's Working Paper No. 3. FAO. Rome.

Stocking, M. with Peake, L., 1985: Erosion-Induced Loss in Soil Productivity: Trends in Research and International Cooperation. FAO and Overseas Development Group. University of East Anglia.

Tietenberg, T., 1988: Environmental and Natural Resource Economics. Second Edition. Scott, Foresman and Co. Glenview, Illinois.

Tolba, M.K., 1987: Sustainable Development. Constraints and Opportunities. Butterworths. London.

Tullock, G., 1987: "Public Choice", pp. 1040-1044 in Eatwell, J., Milgate, M. and Newman, P. (eds.), The New Palgrave. A Dictionary of Economics. Macmillan Press Ltd. London.

UNCOD (United Nations Conference on Desertification), 1977. Desertification: Its Causes and Consequences. Pergamon. Oxford.

UNEP, 1980: Study on Financing the United Nations Plan of Action to Combat Desertification. Report to the Secretary-General. UNEP, A/35/396. Mimeo. Nairobi.

UNEP, 1984: General Assessment of the Progress in the Implementation of the Plan of Action to Combat Desertification 1978-1984. UNEP GC.12/9. Mimeo. Nairobi.

UNEP & Commonwealth, 1987: Drylands Dilemma. A Solution to the Problem. Executive Report: Drylands Project. Published by the Australian Government.

Upstill, G. and Yapp, T., 1987: "Offsite Costs of Land Degradation", pp. 99-107 in Chisholm, A. and Dumsday, R. (eds.), Land Degradation. Problems and Policies. Cambridge University Press. Cambridge.

Varian, H.R., 1978: Microeconomic Analysis. W.W. Norton & Co. New York.

Veloz, A., Southgate, D., Hitzhusen, F. and Macgregor R., 1985. "The Economics of Erosion Control in a Subtropical Watershed: A Dominican Case", in Land Economics. Vol. 61. No. 2.

Wade, R., 1987: "The Management of Common Property Resources: Finding a Cooperative Solution", pp. 219-234 in Research Observer. Vol. 2. No. 2. The World Bank. Washington, D.C.

Walker, D.J., 1982. "A Damage Function to Evaluate Erosion Control Economics", pp. 690-698 in American Journal of Agricultural Economics. Vol. 64. No. 4.

Warford, J., 1987: "Natural Resources and Economic Policy in Developing Countries" pp. 3-17 in The Annals of Regional Science. Vol 21. No. 3.

Williams, J.R., 1985: "The Physical Components of the EPIC Model", in El-Swaify, S.A. et al. (eds.), Soil Erosion and Conservation. Soil Conservation Society of America. Ankeny, Iowa.

World Bank, 1981: Accelerated Development in Sub-Saharan Africa. The World Bank. Washington, D.C.

World Bank, 1984: World Development Report 1984. Oxford University Press. Oxford.

World Bank, 1986: World Development Report 1986. Oxford University Press. Oxford.

World Bank, 1988: World Development Report 1988. Oxford University Press. Oxford.

World Bank, 1989: Striking a Balance. The Environmental Challenge of Development. Washington, D.C.

World Bank, 1990: World Development Report 1990. Oxford University Press.

WCED (The World Commission on Environment and Development) 1987a: Food 2000. Global Policies for Sustainable Agriculture. Report to the WCED. Zed Books. London and New Jersey.

WCED, 1987b: Our Common Future. Oxford University Press. Oxford.

WRI (The World Resources Institute), 1990: World Resources 1990-91. WRI, UNEP and UNDP. New York.

3. LAND DEGRADATION FROM A MACROECONOMIC PERSPECTIVE - THE CASE OF LESOTHO

Introduction

Already in 1935, Pim wrote in his general survey of Lesotho that:

> "The problem of erosion in its many aspects is in fact the most immediately pressing of the many great problems which now confront the Administration." (Pim, 1935, p. 5).

Fifty-five years later, Grainger (1990, p. 71) writes that Lesotho is one of the "worst cases" of soil erosion in southern Africa. Schmitz and Rooyani (1987) report that the level of soil loss on farm land is four times greater than the accepted level, and that 25 percent of the cultivated land is so badly eroded that it should not be cultivated. The seriousness of the matter is further underlined by a recent study of erosion hazards:

> Lesotho has "... the highest erosion hazard of any single country in southern and central Africa." (Chakela et al, 1989, p. 2).

Many similar quotes could be extracted from the rich literature on Lesotho, but the main point is already made: for a considerable length of time, Lesotho has faced a severe erosion problem. And yet, there is still no study that attempts to estimate the economic impact of erosion in Lesotho (NEAP, 1989). In spite of a long history of government and donor intervention to promote land improvement, there have been few efforts to paint a

broad and comprehensive picture of the reasons for land degradation in Lesotho.

In this chapter, an effort is made to draw a broad picture of land degradation in Lesotho. Within the framework for economic analysis drawn up in chapter 2, we set out to systematically trace market and government failures in various sectors, as they relate to land degradation. In particular, there will be a focus on the much neglected field of the relationship between public policies and land utilization. These links can be analyzed in economic terms on three major levels:

(1) The **general policy** level, where the major decisions regarding the assignment of property rights, the degree of planning vs. market control, fiscal and monetary measures and so on are made. The links between these overriding decisions to land degradation may not be obvious, but nevertheless at times quite strong.

(2) The **land utilization policy** level, where conscious decisions are made to limit land degradation and promote improved land management through legislation, subsidies, agricultural extension, etc.

(3) The **land improvement project** level, where specifically designed measures are directed to a limited area during a specific time period, often under the guidance of a special administrative organization.

The previous chapter dealt with the first two levels from a general perspective. This chapter will consider the same themes, but applied specifically to Lesotho.[1] The **purposes** of this chapter are to analyze:

(1) The economic significance of crop land degradation for the national economy of Lesotho.

(2) The nature and extent of market failures affecting land degradation and improvement in Lesotho.

(3) The impacts of government policies on land degradation and improvement.

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1. Chapters 4 and 5 will focus on the project level.

The analysis under point (1) is quantitative, while data availability and the stage of modelling of the Lesotho economy does not allow more than a qualitative analysis of the other two points. Hopefully, the description and discussion can still serve as a guide to identify the areas where future efforts of more rigorous, quantitative analysis would be useful.

The chapter is organized as follows. Section 3.1 contains an introduction to Lesotho. Section 3.2 takes the case studies of soil erosion cost accounting on the national level presented in chapter 2 as a point of departure, and makes a quantitative case study for Lesotho. From the more general perspective drawn in chapter 2, section 3.3 goes on to consider the functioning of markets and public policies, in order to qualitatively determine their impact on land degradation and rehabilitation in Lesotho. The discussion is not limited to a discussion of the purposeful policies affecting land utilization, but takes into account a wider spectrum of links through the economic system. Section 3.4 summarizes the chapter and draws conclusions.


Africa
LESOTHO
BUTHA-BUTHE
LERIBE
BEREA
MOKHOTLONG
MASERU
THABA-TSEKA
MAFETENG
QACHA'S NEK
MOHALE'S HOEK
QUTHING
N
Northern Lowlands
Southern Lowlands
Mountains
Foothills
Senqu River Valley

3.1 Lesotho - A Brief Introduction[2]

Before turning to the details of land utilization in Lesotho, it is appropriate to briefly review the overall geopolitical and economic situation of the country. Lesotho was shaped in the 19th Century by King Moshoeshoe I (1786(?)-1870), who skilfully united small, hostile groups of cattle herders. Seeking support and protection from the British against the advancing Boers, Lesotho became a colony by political necessity. The shape of current Lesotho was defined in negotiations with the Boers ending in 1869. In 1871, "Basutoland" (named after its people)[3] became a protectorate, linked to the Cape Colony. It became a separate, British crown colony under indirect rule in 1884. Independence from the United Kingdom was obtained in 1966.

The post-independence history of Lesotho can roughly be divided into two phases. The first, 1966-86, was dominated by the Basotho National Party (BNP), headed by Chief Leabua Jonathan. In January 1986, a military coup removed Jonathan and established a ruling Military Council. Its composition has changed at times, but the basic structure remains the same as of June, 1991. However, a new constitution is being elaborated and democratic elections are scheduled to take place in 1992.[4]

The Kingdom of Lesotho has some unique geographical features.[5] It is completely surrounded by the Republic of South Africa (RSA). Lesotho is a highland country. The lowest point of elevation in Lesotho - 1300 metres above sea level (BoS, 1989, p. 3) - is the highest of any nation. The country is divided into four physiographic units: The Mountain and Lowland regions separated by the

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2. Recent, more in-depth presentations of Lesotho are available in Lundahl and Petersson (forthcoming), MoP (1987) and Petersson (1989, 1990).
3. The modern spelling is generally "Basotho" (Sing. "Mosotho") to denote the ethnic group which is by far the largest part of the population.
4. The recent political development will be discussed below in the section on political élites.
5. The geographical description draws on Rydgren's chapter in Bojö et al (1988). See also Schmitz (1984) and Schmitz and Rooyani (1987) for detailed descriptions.

Foothills region, and the more limited Senqu River Valley.

The Lowlands form a narrow strip along the western and southwestern parts of the country. They are separated from the Foothills by steep slopes and sandstone cliffs. The Lowlands range in altitude from 1388 m to 1800 m above mean sea level. The climate of the lowlands is cool to hot with a mean annual temperature of approximately 15 degrees C. The winters often experience subzero temperatures with frost during most nights. The mean annual rainfall ranges from 500 mm in the south to about 800 mm in the north. Most of this rain occurs between October and April. The Lowlands have a marked dry season from June to August.

The indigenous vegetation is predominantly grasslands. The land is extensively cultivated and grazing is limited to steep slopes, along the edges of the sandstone hills. The areas between cropland boundaries and along the gullied areas are also normally used for grazing. The major settlements in the country are located in the Lowlands. The result of the heavy human and livestock population is extensive erosion and overgrazing.

The altitude of the Foothills region ranges from 1800 to 2000 meters above mean sea level. The climate differs from the Lowland in that the mean annual temperature is lower, and the rainfall is higher - up to 1000 mm. It often snows in the winter. The vegetation of the Foothills is dominantly grasslands. The hillslopes support some indigenous trees and shrubs. There are also apparent signs of land degradation in this region. Because of the nature of the soils, gullies are not as spectacular as they are in the Lowlands.

The Mountains cover the land situated above 2000 meters above mean sea level. The region is dominated by rolling lava plateaux and flatfloored valleys with steep sides. The climate is cool to cold with frequent snowfalls in winter. The Mountains form the major summer grazing lands for Lesotho. Overgrazing of the pastures is a frequent feature and is the dominant land degradation hazard of

this region. Limited crop production occurs in the valley bottoms.

Some key country data are given in the table below.

Table 3.1 Key Data for Lesotho (1988)

Area:	30 thousand km^2
Population:	1.7 million
Population growth (1980-88):	2.7% per year
GNP/capita:	USD 420
Real GNP Growth (1965-88):	5.2% per year
GDP/capita:	USD 194
Average life expectancy	56 years

Source: World Bank (1990b).

The Economic Structure and Economic Policies

A primary feature of the Lesotho economy is its dependency on the economy of the Republic of South Africa.[6] The major source of income in Lesotho is mining in the RSA. This is the major explanation behind the unusual discrepancy between GNP and GDP as shown in table 3.1. There have been some 114-129 thousand registered mine workers in the RSA during the 1980s. The total number of migrant workers is even higher, and was estimated to some 165 thousand in 1986 (Petersson, 1989).

An issue of overriding economic concern for the country is therefore how it will be affected by political changes in the RSA. The persistent fear in Lesotho of large-scale lay-offs of Basotho mine workers has also been used as an argument for investments in land rehabilitation measures as an "insurance".

The pessimistic scenario of declining migrant labour opportunities has several arguments attached. First,

6. See Petersson (1990), and for further details Lundahl and Petersson (forthcoming).

there is the fact that unemployment is quite high in the RSA. An approximate figure is that 37 percent of the economically active population was "unemployed" (1985), and the tendency has been for this figure to rise over the preceding 25 years (Lundahl et al, 1990). The recent and prospective political changes in the RSA imply an increasing pressure on job creation for nationals. Basotho constitute by far the largest non-national group of mineworkers, with a share of almost 1/5 of total African mine employment in 1987 (Ibid.). A second argument for the pessimistic scenario is that advances in the mechanization of mines imply the use of less labour per unit of production. Third, international sanctions have hit the mining industry, with depressed employment opportunities as a result (MoP, 1987).

However, there are also good reasons against the scenario of a strong decline in Basotho mine worker recruitment. First, it should be noted that the recurrent rumours of declining mine recruitment from Lesotho are not supported by statistics.[7] After some decline in the early 1980s, the figures have risen since 1984 to a record level of almost 129 thousand registered mine workers in the second quarter of 1990 (Central Bank, 1990b).

A second reason for some optimism regarding future mine employment, is that 80 percent of the Basotho mine workers are classified as "skilled" (EIU, 1990b). Their replacement would be very difficult and resisted by the politically influential mine owners. Thirdly, a sharp fall in Basotho employment would cause social and political unrest with international repercussions, which is likely to be of some concern for the government of the RSA, regardless of the colour of its members. Finally, the argument about sanctions hurting the mine industry may soon be obsolete due to political changes in South Africa.

On balance, we can only make a very subjective assignment of probabilities to various scenarios. Some downward adjustment of Basotho mine employment is not unlikely, but a drastic and deep fall in numbers is. On the other

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7. Recruitment is highly centralized through The Employment Bureau of Africa (TEBA) and the statistics on the number of mine workers are considered comparatively reliable.

hand, some increase in recruitment may follow a relaxation of international sanctions, which is a likely prospect at the time of writing. A somewhat reduced number of workers may still bring home increasing real wages. In particular, if white mineworkers' jobs of a more qualified nature become available to experienced Basotho, this could increase real wages substantially. However, to the extent that immigration for entire Basotho families into the RSA also becomes easier, there might be a decline in wage remittances going back to Lesotho.[8]

Since 1979, Lesotho has had its own currency, the Loti, plural Maloti (M) on a par with the South African Rand. The Loti is issued by the Central Bank of Lesotho (in operation since 1982), but must have complete coverage by interest-yielding deposits in the RSA in hard currencies. Obviously, this severely limits the room for independent monetary policy. The Loti has followed the Rand in its sharp decline since the early 1980s, to a level of M 2.59 per USD (average, 1990; EIU, 1991).

Lesotho is a member of the Southern African Customs Union (SACU), the other members of which are the RSA, Botswana and Swaziland (RSA, 1969). Tariff revenue is a major source of income for the government of Lesotho. Practically all foreign trade is with the RSA. Major import items are wearing apparel and food. Exports amounted to 13 percent of the import bill in 1989 and comprised mainly textiles, leatherwear, mohair and wool. (EIU, 1990b).

Foreign aid to Lesotho is substantial. Net ODA from all sources was USD 108 million in 1988, corresponding to 26 percent of GNP the same year. This implies USD 65 in per capita terms, a figure substantially higher than the average for low-income countries: USD 7.6 per capita. (World Bank, 1990b). The major donors are, in order of gross development assistance in 1988: USA, EC, West Germany, the UK, African Development Fund, IDA, Sweden and the World Food Programme. While donor support declined 30 percent in real terms from 1980 to 1986, commitments rose substantially in 1987 and 1988 following

8. Current Basotho entry to the South African labour market is severely circumscribed. See Murray (1981) for details.

the agreement on an IMF programme of structural adjustment (EIU, 1990b).

The IMF programme was approved in 1988 and includes a Structural Adjustment Facility worth USD 12.4 million (1988) over three years. The main objectives of the programme are to increase economic growth and reduce the budget deficit. The deficit peaked in 1988/89 at a level of 18 percent of GDP. The IMF programme targets the level at 4 percent in 1990/91, following cuts in recurrent expenditure and measures to raise revenue. (EIU, 1990b).

Total foreign debt has risen strongly in the 1980s, and reached a level of 42 percent of GNP in 1989. However, the debt service ratio is still only 3.3 percent, and there are no arrears on debt service. Most of the loans taken are concessional, with a maturity period of 40 years or more. (EIU, 1990b).

Turning to the composition of domestic production, the structure of the GDP is as follows.

Table 3.2 Percent of GDP in 1980 and 1989

	1980	1989
A. Primary sector	**31.8**	**19.4**
Agriculture	23.4	19.0
B. Secondary sector	**20.7**	**34.4**
Manufacturing	6.6	15.7
Construction	13.4	17.9
C. Tertiary sector	**47.5**	**46.2**
Domestic trade	7.1	9.0
Public admin.	12.0	9.5
Education	10.1	7.6
Total (A+B+C)	**100.0**	**100.0**

Source: BoS (1990b)

The trend of falling importance of the primary sector of GDP, and an increased role for the secondary sector is visible in the table. In particular, manufacturing, including handicrafts, has grown rapidly. However, it is still a small employer, with only some 10 thousand employees (EIU, 1990b). The government pursues a generous policy towards foreign investors, providing financial concessions and administrative services (MoP, 1987; Wellings, 1986).

While mining in the RSA is the major economic activity of Basotho in terms of income, agriculture still employs the majority of the people. Even if the relative importance of agriculture is declining, it remains important as a source of income for sections of the rural population, where poverty is particularly pronounced.

Income Distribution

First, a note on terminology. Total income is made up of cash income and income in kind. As Lesotho is a thoroughly monetarized economy, cash income amounts to about 90 percent of the total income. The difference is made up of subsistence production, earnings paid in kind and imputed value of owner occupied dwellings. Furthermore, the level of in kind income is rather stable between income groups. (Eklöf and Molapo, 1989). This may appear surprising, but is probably a result of the fact that (a) the penetration of cash remittances to rural areas is extensive and (b) even high-income earners retain an agricultural side-line to a large extent.

The distribution of (cash) income in Lesotho is quite skewed, as illustrated by the table below. The poorest 25 percent survive on less than 2 percent of all cash income, while the top 25 percent receive more than 60 percent.

Table 3.3 Cash Income Distribution in Lesotho

Income group M/month	Percent Income	Percent Popul.	Accumul. Popul.	Accumul. Income
0-40	1.5	25	25	1.5
41-112	9.2	25	50	10.7
113-263	28.2	25	75	38.9
264 +	61.1	25	100	100.0

Source: Eklöf and Molapo (1989, p. 5)

The inequality of income is most pronounced in the rural areas with a Gini coefficient[9] of 0.69, as compared to 0.51 for the capital (Maseru) urban area and 0.53 in other urban areas (Ibid.). While international comparisons are difficult to make due to differences in concepts, methodology, survey dates and reported categories, it appears that this is an extremely skewed distribution even for a developing country - compare the World Bank Development Report (1990b).

What are the reasons for this extreme inequality? Starting with the upper end of the distribution, an increasingly well-organized mine worker force has managed to raise real wages substantially from the 1970s and onwards (Lundahl et al, 1990). The average wage for a black worker in a South African Chamber of Mines operation, was about M 7 600 (USD 2 900) per year in 1988 (Central Bank, 1990b). This can be compared with the average GDP per capita of about USD 200 for the same year. Furthermore, formal sector employment, primarily in the form of Government appointments, awards relatively well-paid positions, as the small share of well-educated Basotho must be retained in competition with the South African labour market.

The Agricultural Sector

For purposes of tracing impacts of public policy on land utilization, the major agricultural sectors of livestock

9. The Gini coefficient is closer to zero the more equal the distribution is, and closer to unity the more unequal the distribution is.

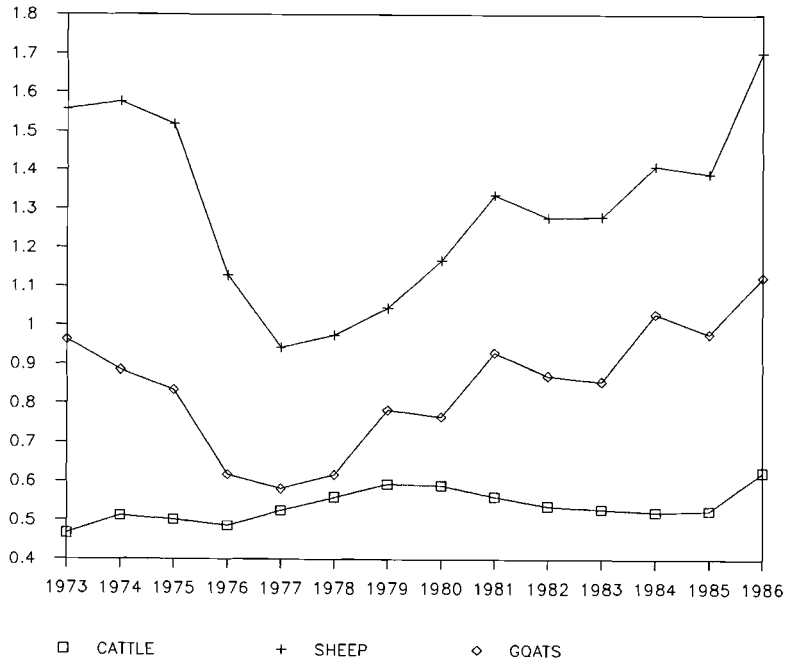
and crop production are of prime interest. Therefore, these sectors will be discussed more in detail below.

The **livestock sector** accounted for 47 percent of the **agricultural** GDP in 1989, which is almost exactly the same share as for crops, vegetables and fruits together (BoS, 1990b). From a land utilization point of view, it is also of prime interest as it covers a major portion of the land in Lesotho. As much as 80 percent of the land is regarded as suitable for livestock raising (World Bank, 1986).

Livestock are kept for a variety of economic and social reasons. The reasons for holding livestock can be described primarily as economically rational, although motives of prestige are not absent (Swallow et al, 1987; Hahn, 1990). Sheep and goats produce wool, meat and the famous mohair. Large stock are used for draft power and produce milk, meat and hides. They also function as a store of relatively inflation-safe wealth and a sign of social prestige.

Patchy data on livestock populations are available from the 1830s and onwards, but a continuous time series is only available from 1973. Fluctuations have been considerable for all categories of livestock. The most plentiful category is sheep. The number of sheep peaked already in the 1930s, but is now almost back on the same level. The number of goats is now higher than the previous record level of the early 1900s, after a fluctuating decline for some decades. Finally, the number of cattle is higher than ever historically recorded. (Swallow et al, 1986; BoS, 1990c). The most recent available figures on a selection of livestock are shown in diagram 3.1. In addition, there is a considerable number of horses, donkeys, poultry, and a limited population of pigs.

Diagram 3.1 Livestock Population in Lesotho (million)



Sources: Swallow et al (1977), BoS (1990c).

The livestock sector in Lesotho is signified by overstocking[10], range degradation, low marketed offtake, low reproduction and high mortality (Swallow et al, 1987; LNLTF, 1990). The degree of overstocking is a controversial issue, and estimates have varied considerably. The National Environmental Action Plan quotes estimates varying from 150 to 300 percent, and describes overstocking as the key environmental problem in Lesotho (NEAP, 1989). However, more recent and authoritative estimates put the rate of overstocking at around 50 percent (Meissner, 1989, LNLTF, 1990) or 40-80 percent (MoA, 1988a). This is not the place to try to resolve this issue, as the crucial point can still be

10. The concept of "overstocking" generally used is with reference to the "carrying capacity" of rangeland. While rarely explicitly defined, it appears to denote the biological maximum sustainable yield of the range, rather than the economic optimum.

made in spite of prevailing uncertainty: the range is heavily overstocked.

Furthermore, the number of households owning livestock is decreasing. Only half of the households now own livestock. (NEAP, 1989). Thus, the "communal" range is an asset which does not directly contribute to the welfare of a considerable part of the community.

Faced with this situation, Lesotho authorities, with the help of donor agencies, are engaged in a programme involving adjudication of transhumance,[11] the establishment of grazing associations promoting controlled grazing, and a grazing fee. We will return to these measures in section 3.3.2.

Section 3.2 contains a detailed statistical analysis of the **crops sector** in Lesotho. Therefore, a few words of introduction will suffice here. The climate allows the cultivation of temperate zone crops such as maize, sorghum, wheat, beans, peas and fruits. The first three make up about 90 percent of the area cultivated. Agriculture in Lesotho is critically dependent on natural precipitation. The actually irrigated land amounts to only 1 800 ha (IMF, 1989) while the potentially "irrigable" land is estimated at 17 000 ha (MoP, 1987). Drought during the growing season and the occurrence of severe frost even into the summer months create a hazardous climate for agricultural activities.

In addition, only some 10-13 percent of the land in Lesotho is arable, and the average farm holding is down to a minimum for subsistence per family. The number of landless households has increased to 25 percent in 1986. (NEAP, 1989). Crop production has therefore become insufficient to feed the growing population. Even a normal year, about 25 percent of the basic foodstuff requirements have to be imported (EIU, 1990b). Contributing to low production is the extensive male labour absenteeism in the RSA, which also restricts decision-making on land management.

Forestry is a very minor sector in Lesotho. There are no signs of large forests ever having covered Lesotho.

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11. Transhumance is the seasonal moving of livestock to another region.

Energy requirements are largely met by collecting fuelwood from trees and shrubs, dung and crop residues. Denudation of the landscape is a significant problem, which will be aggravated in the future. (LEMP, 1988). This issue will be returned to below, particularly in the section on population.

3.2 The Cost of Soil Erosion to the National Economy

Agricultural production in Lesotho is primarily a matter of livestock production, and secondarily a matter of crop production. Limitations of data and expertise dictate a focus on the latter. An analysis for the livestock sector, similar to the one carried out here, remains a challenging task for future research.

The **purpose** of this section is to attempt to assess the impact of erosion on crop production and yield in Lesotho, and its macro economic significance. First, available data on crop performance in Lesotho is reviewed. A number of possible explanations behind the development of production and yield are discussed in qualitative terms, and some regressions and graphs are used to uncover relationships on a preliminary basis. Second, a number of single equation models for the national aggregate production of the major crops in Lesotho are tested through multiple regression analysis. Third, differences in erosion rates across districts are used to test whether any statistically significant impact can be traced with regards to trends in yield. Finally, the macroeconomic implications of declining production are discussed.

3.2.1 Crop Performance

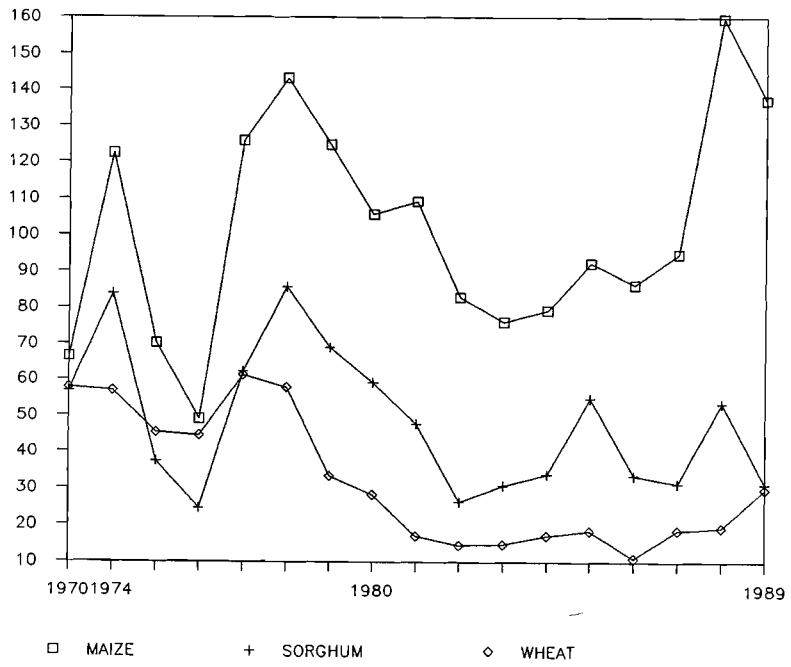
The crop sector is primarily a matter of maize, sorghum and wheat production, constituting some 90 percent of the area devoted to crops, as an average for the past couple of decades. Minor crops such as beans and peas will be disregarded in this context. A common notion of crop cultivation in Lesotho is that it is a sector on the decline: "... annual variations do no mask a secular decline in yields and output of traditional crops." (EIU, 1991, p. 12). This section presents results that can give some nuance to that notion.

A note on data availability and quality is in order before we proceed.[1] Crop statistics based on uniform and statistically sound crop cutting procedures are available for the agricultural years 1949/50, 1960/61, 1969/70 and

1. A detailed description of agricultural data collection procedures in Lesotho is available in Olsson (1988).

1973/74 - 1988/89. There are also other crop statistics going further back in time, but those estimates are not based on equally reliable methods. They have therefore been disregarded. In addition, the data from the first crop cutting analysis (1949/50) has been subject to strong criticisms (Eckert, 1980, Hesling, 1984) and has been deleted from the data set used here. The year 1960/61 has also been deleted, because a complete set of variables could not be obtained for that year. This limits the data set to 17 years of observations. Area data are based on actual measurements, not on farmer interviews. The statistics used in this section have primarily been obtained from unpublished and published data from the Bureau of Statistics in Lesotho. The production of maize, sorghum, and wheat is shown in diagram 3.2. Apparently, production has fluctuated considerably.

Diagram 3.2 Crop Production in Lesotho (thousand ton)



Source: Lesotho Bureau of Statistics.

By regressing the production data on time it can be observed that:

- maize has a positive but insignificant trend coefficient;
- sorghum has a negative and significant (10 percent level) coefficient;
- wheat has a negative and significant (1 percent level) coefficient;

However, analysis on this level tells us nothing of the underlying reasons for these trends. A significant erosion impact on production could have been counterbalanced by improvements in agricultural management. To start to decompose the picture, one may write output as an identity with two components:

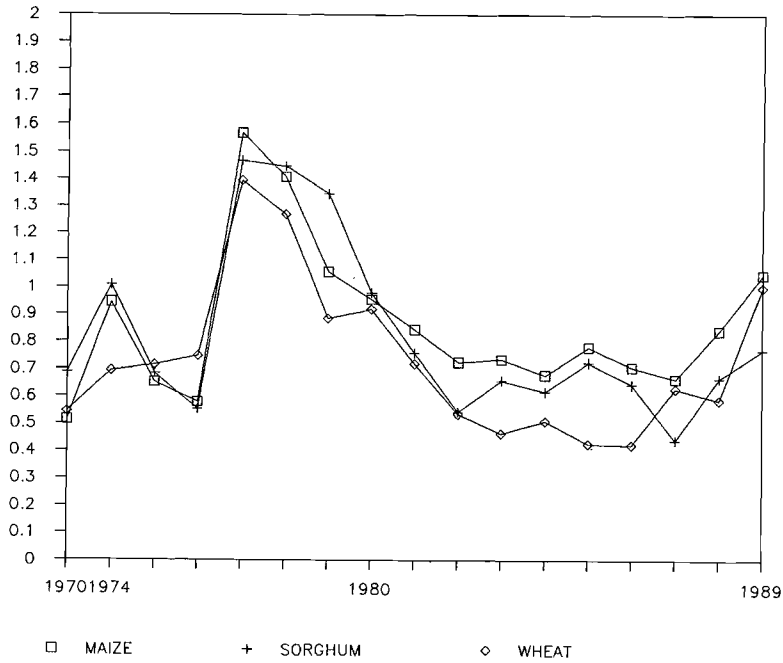
$$Q = Y * AH$$

where

Q = grain production of a particular crop in tons
Y = yield: production in tons per hectare harvested
AH = area in hectares harvested of a particular crop

Starting with yield, diagram 3.3 shows the yield per hectare of maize, sorghum and wheat. The impression is that there have been considerable fluctuations in yield from year to year. However, a regression of yield on time displays a **negative but insignificant** coefficient for all three crops. Whatever the negative impact of erosion on crop yield is, this appears to have been balanced by counteracting forces.

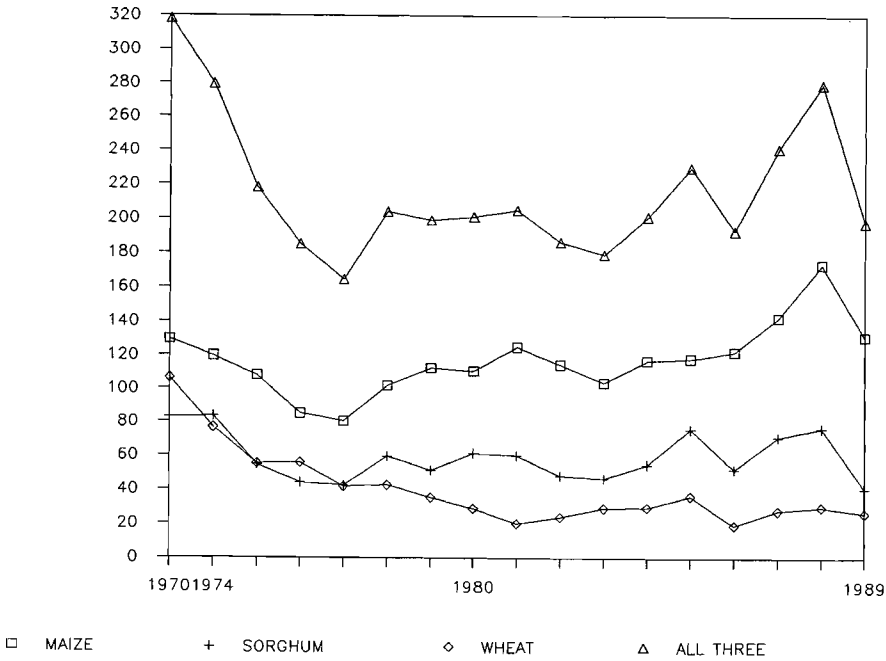
Diagram 3.3 Crop Yield in Lesotho (ton/ha)



Source: Lesotho Bureau of Statistics.

Proceeding to the AH variable, diagram 3.4 shows how the acreages of maize, sorghum and wheat as well as an aggregate of all three have changed over time. The total area shows a marked decline in the 1970s with a trough in 1977. This drop in cropped areas has been attributed to the increase in migrant labour recruitment and to strongly increased real wages at the time (Eckert, 1980). However, it appears that areas harvested have picked up again, particularly so for maize.

Diagram 3.4 Area Harvested (thousand hectares)



Source: Lesotho Bureau of Statistics.

A driving force behind the tendency to extend the cropping area is the the increasing rural population in Lesotho. Only a part of this is drained to the cities, and many remain in the rural areas, where the pressure to utilize land for cultivation increases. However, additional factors must be added to explain the fluctuations between years. The timing of rain at planting time is one factor to consider in that respect.

The next step in the decomposition of crop production is to look at the determinants of yield and area respectively. However, before we venture into the details, a look at how previous statistical studies have dealt with the subject is warranted.

3.2.2 Previous Studies versus the Present

As far as we have been able to ascertain, there are no previous studies in Lesotho, made with the purpose to uncover any influence on crop production of erosion. More generally, the subject of national or district level crop production in Lesotho, as related to various background variables, has not been the subject of any major research. Only a few, basic studies have been identified: Eckert (1980, 1982), Hesling (1984) and MoA (1979). In relation to previous studies, the current one differs on several accounts.

1. Our purpose is different. While it is interesting to explain the development of crop yield and production in general, we are particularly interested in detecting any statistically significant influence of **erosion** on yield. This has not been a variable considered in previous studies.

2. Data quality and availability has improved. This study has the benefit of using almost a decade of consistently gathered data not available to the latest previous study. Some of the older data is of inferior quality, and has been excluded from this study.

3. The construction of the important rainfall variable is improved. Previous studies have used rainfall data from the district capitals only. These are often not well situated to reflect rainfall in crop production areas when used as the only source of data. As will be explained below, a more adequate measure is constructed here.[2]

4. Statistical data about acreage cropped is included, which has not been a part of the previous studies encountered. As shown above, the area harvested has varied considerably over time. Apart from the obvious relationship to production, it might also have an impact on average yield. The inclusion of area harvested as an explanatory variable makes it problematic to estimate yield functions. Yield is derived as production over area

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2. The idea to use 5-day rainfall data had to be dropped as the computerized entries of daily data were unobtainable. Therefore, monthly data had to be entered manually from Meteorological Bulletins.

harvested, thus introducing a problem of simultaneity. Disregarding for a moment other variables, the yield function could be written:

$$Y = a + b * AH + \ldots + u$$

where

u = a stochastic error term

However, by definition,

$$AH = Q/Y$$

which implies that

$$AH = Q/(a + b * AH + \ldots + u)$$

which shows that AH is influenced by the error term u. The application of OLS (Ordinary Least Squares) to the yield equation would result in inconsistent estimates (Johnston, 1984, p. 440). Therefore, only production functions have been estimated here. This is no disadvantage from the particular perspective from which we are approaching the problem of erosion in this chapter.

5. This study considers not only maize as MoA (1979) and Eckert (1980, 1982), but sorghum and wheat as well. However, the analysis of wheat is limited to the district level analysis. National data for wheat would have to be disaggregated into two growing seasons, in order to relate performance to monthly or seasonal rainfall. This has not been possible within the limits of this research.

6. Only Eckert (1980) previously analyzed district level data. A new approach (for Lesotho) is used here to relate **trends** in district yields to district levels of erosion.[3]

7. Differing with Eckert, data for particular years showing deviations in the first run of the model will not be eliminated on an ad-hoc basis. This will give the regressions lower explanatory values, but will more accurately depict the true level of ignorance.

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3. See Crosson and Stout (1983) for a similar approach used on USA data.

8. Different functional forms are tested here and the properties of derived estimates are discussed using a set of standard econometric tests.

3.2.3 The Production Function

Based on theoretical considerations, the following production function is suggested:

$$Q = f\ (AH,\ R,\ CE,\ L,\ K,\ F,\ SQ,\ ST)$$

where

Q = production in tons
AH = area harvested in hectares
R = plant-available precipitation in mm
AE = accumulated erosion in ton/ha
L = labour input in days per hectare
K = capital input per hectare
F = fertilizer added to the soil in kg/ha
SQ = seed quantity in kg/ha
ST = seed type (dummy variable for hybrid/local seed)

A discussion of the RHS variables is in order. The AH (area harvested) variable has been discussed above, and needs no further elaboration. The R (rainfall) variable is generally considered to be a strong determinant of crop production in Lesotho. As noted in the introduction, irrigation is virtually non-existent. Drought has negatively affected crop production for several years in the early 1980s (BoS, 1987; World Bank, 1986). In this study, five types of aggregations and adjustments will be used in order to improve the relevance of precipitation data.

1. For each district, 2-3 stations have been selected to reflect crop production area rainfall. An unweighted average is taken to reflect **district** rainfall per month.

2. As rainfall is only a gross contribution to plant available water, **evaporation is subtracted** on a monthly basis, to arrive at a better approximation of net

available precipitation ("net rainfall"). Evaporation data are published since 1977 by the Meteorological Department in Maseru.[4] The number of stations is limited, but variation is not considerable across stations. Therefore, the same (unweighted average) monthly figure is used throughout the country. This still serves to moderate the influence of individual months within the same year, as well as total net rainfall across years. For years previous to 1977, the monthly average over all recorded years is inserted.

A more sophisticated approach would take into account evapotranspiration as a function of temperature, wind velocity, humidity and so on, but such data are not available. Adjustments for differences in water holding capacity of various soils are not possible to make on the scale considered in this study. Soil conditions vary significantly even within an area of a few hectares, and cannot be easily generalized upon.

3. To obtain the **national** monthly rainfall figure, district net rainfall data are weighted on the basis of each district's average share of the production of maize and sorghum respectively, for the agricultural years 1969/70 and 1973/74-1988/89.

4. **Seasonal** national level rainfall is aggregated from national monthly data selected to reflect the actual growing season. This is determined by a look at the amount of rain less evaporation in September-October. If less than 50 mm, the planting is assumed to be "late", making the rainfall season October-April relevant. If 50 mm or above, the planting is assumed to be "early", making the relevant rainfall season September-March.

5. An alternative to aggregated rainfall seasons are **monthly** data, entered as individual variables. This approach is also tested, and months are eliminated in a stepwise regression, on the basis of the degree of significance of coefficients.

Turning to the accumulated erosion (AE) variable in our production function, the only national inventory on this

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4. Evaporation is (throughout the period) measured as the amount from a class A pan surface (i.e. from the open surface of a water pool without any vegetation).

point is reported in MoA (1988b). This shows district-wise the rate of water-induced erosion as of 1988, using USLE[5]. These estimates are useful in the district level analysis below. Unfortunately, there is no time series available for erosion. A crude proxy variable for the accumulation of soil loss is derived by using the rate of soil loss registered for 1988, assuming an equal increment each year. Thus, the national average accumulated soil loss is:

$$AE_t = E * t$$

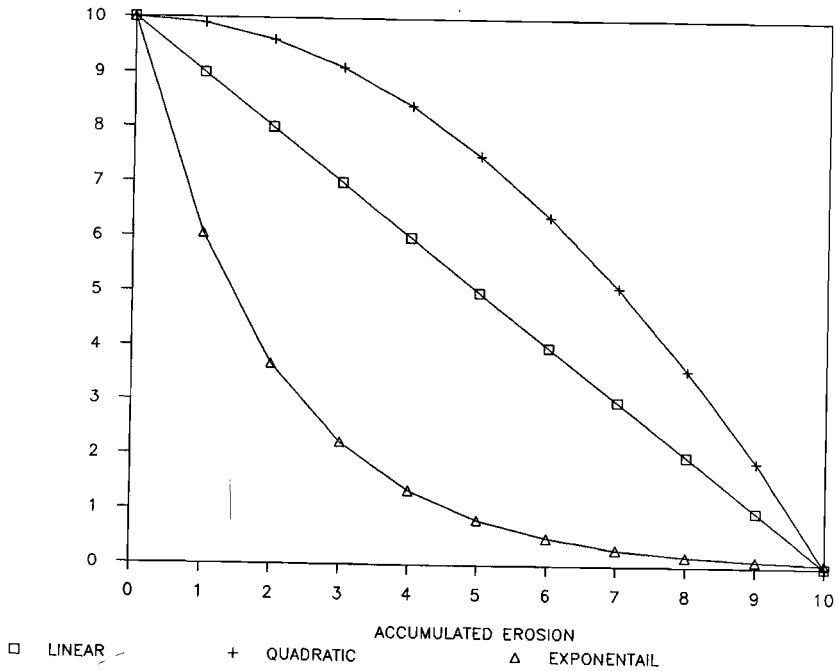
where

AE = accumulated erosion in tons per hectare
E = average crop land erosion rate in 1988 in ton/ha
t = time in years (t = 1, 5 ... 17)[6]

The way in which this variable should enter the production function requires some additional comment. The shape of the accumulated erosion-production damage function depends on the nature of the soil. If the nutrients are concentrated to a thin layer of top soil, with poor but thick sub-soil below, one should expect a decline in productivity which is drastic initially, but slows down in the sub-soil layer. One could also imagine a uniform soil where initial erosion would do little to harm productivity, as long as rooting depth and water holding capacity are sufficient. Once a critical level is reached in those respects, productivity decline could be rapid. The former type of soil conditions would indicate a negative exponential form, the latter a negative quadratic form. Linear approximations could be appropriate on some soils. These stylized assumptions are illustrated in the diagram below.

5. Universal Soil Loss Equation, see chapter 4, section 6 for an explanation.
6. There is a gap for t = 2, 3 and 4 as data for 1970/71 - 1972/73 are not of comparable quality.

Diagram 3.5 Stylized Erosion-Productivity Functions



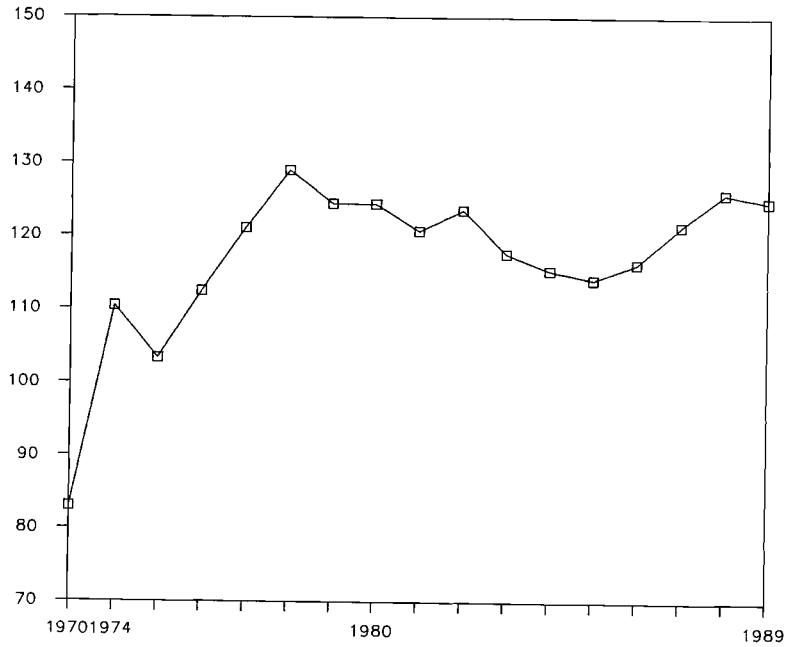
Empirical studies have shown good fits for all three types of functions: Lal (1981), Vittal et al (1990) and Hurni (1985) each provide an example. As soil conditions vary, it is difficult to generalize about conditions in Lesotho. Thus, all three functional forms will be tried here.

With respect to the labour (L) variable in the production function, two aspects need to be separated. One is whether an increased labour supply affects the **area** cultivated, the other is whether labour **input per area unit** has changed. The first aspect is caught by using the AH variable directly in the function and needs no further consideration. The second aspect of labour intensity requires further comment.

One view is that there is a labour constraint in Lesotho agriculture. The hypothesis is that male labour migration to the RSA has drained the rural areas of its best physical labour and hampered effective agricultural

decision-making (Eckert, 1980). The number of migrant mine workers going to South Africa has remained relatively stable over recent years, as shown in the diagram below.

Diagram 3.6 Migrant Mine Workers (thousands)

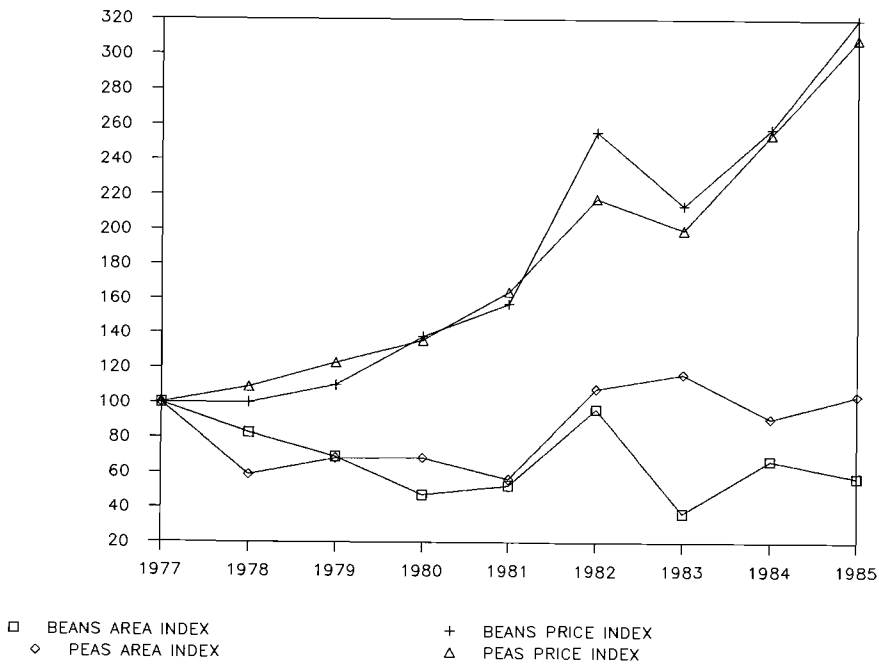


Source: Central Bank (1990b).

While changes in migrant labour recruitment in themselves may not have affected labour ability, a stable level must have left an increasing labour force behind in the rural areas. To some extent, this should have been absorbed by the crop area expansion in recent years, but some degree of intensification cannot by ruled out. If this is the case, one should observe a shift from less labour intensive to more labour intensive crop production in the rural areas.

The relative labour intensity of maize and sorghum is a matter of dispute and other crops must be considered for comparison. Labour studies from Lesotho concur that beans are a more labour intensive crop than both sorghum and maize, and that peas are a much less labour intensive crop (Holland and Ts'iu, 1983; Plath, 1982). It is interesting to see whether there are any pronounced trends as to the cultivation of beans and peas. Production will not be used as a measure, as this is so much affected by exogenous forces that cannot be controlled or anticipated ex-ante. However, the area planted is a variable over which the farmer has control, and should give some indication of a possible changing pattern of production due to increasing labour abundance. A comparison is also made in the diagram below between the prices of the two crops, to control for any relative price changes that may affect area planted.

Diagram 3.7 Beans and Peas: Prices and Areas Planted



Sources: Adapted from BoS (1986, 1990c).

The diagram shows that the relative price of peas and beans has been virtually constant in 1977-1985. The areas planted exhibit no definite trend, and the area with beans - the labour intensive crop - has tended to lie below the curve for peas - the less labour intensive crop. This gives some indication that, at least for the short time analyzed here, there is no sign of a drift towards more labour intensive cropping in Lesotho.

There is no consistent time series of labour input studies that could provide a sound statistical foundation for concluding that labour intensity has largely remained the same, but on the grounds discussed above, we nevertheless make the qualitative judgement that this is probably true. Therefore, the L variable is dropped from the equation.

As for the K-variable, the agricultural production techniques have not undergone fundamental changes in the time span under study. Data is scanty and lags behind, but the number of tractors can serve as a crude indicator of capital intensity. It has remained very small, and with no significant trend, as shown in the table below.

Table 3.4 Total Tractor Registration in Lesotho

1976	1978	1980	1982	1984	1986
1143	1427	1535	2054	1237	1746

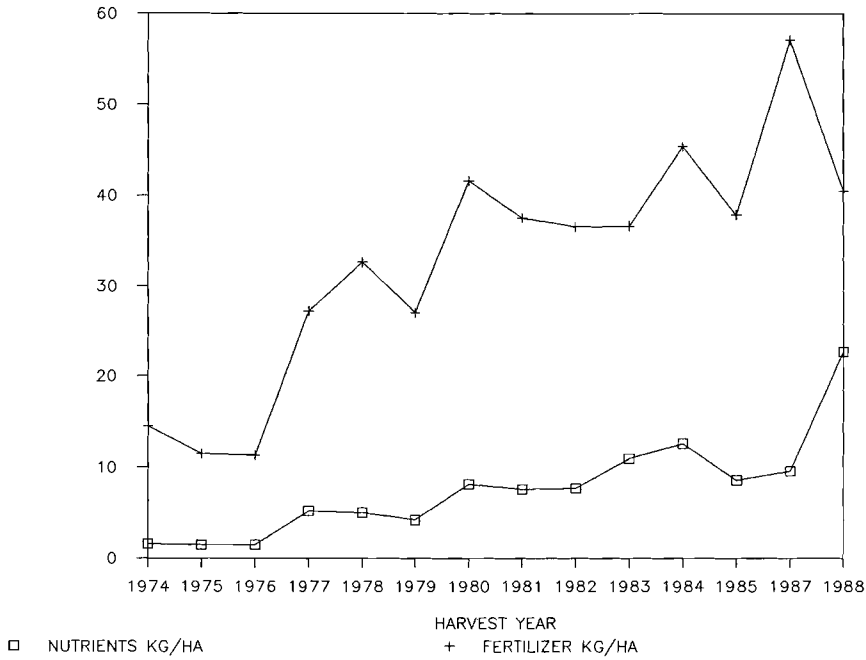
Source: Bureau of Statistics (1986, 1990b).

Two caveats apply when interpreting the table above. The first is that there may be tractors operating without official registration. As such registration involves fees and bureaucratic struggling in district capitals, this is likely to deter some tractor owners from legalizing their ownership. The second point is that tractors from across the border are sometimes used in accessible areas. Neither of these factors can be substantiated by statistics. There is no basis for assuming that significant technological changes have occurred in the

past couple of decades, which is the time span considered here. The K variable is therefore omitted as an argument in the production function.

As for the fertilizer (F) variable, diagram 3.8 shows the supply of fertilizer per hectare planted, and fertilizer re-calculated to nutrients per hectare planted to allow for differences in concentration of nutrients. Data show a substantial relative increase for this period. However, the absolute level of fertilizer input is still low: some 40-50 kg/ha, as compared to the official recommendation of 250 kg/ha. One hypothesis to be examined later, is that this has still significantly influenced production and yield upwards, thus counterbalancing the depressive force of erosion. Changes in the composition of fertilizer type used may explain the partial discrepancies in tendency between the curves. As background details are not known, both variables are tested in the regressions.

Diagram 3.8 Fertilizer and Nutrients (kg/ha planted)



Sources: BoS (1986) and unpublished data.

As for seed type (ST), hybrid seed has been introduced in Lesotho, but there are no data available on the time trend of sales. However, from unpublished records from Coop Lesotho for the 1989/90 season we estimate that a total of some 450 tons of hybrid seeds of maize were sold. At a rate of 15 kg/ha, this translates to 30 thousand ha, or about 15 percent of the area used for maize cropping in 1989/90 (BoS, unpublished data). Thus, this may have some impact on national yields, as an increase of yield with, say 50 percent, on 15 percent of the land implies an increase of 7.5 percent in average productivity. The conclusion is that this may be a factor influencing output upwards. However, in the absence of time series data, this variable must be omitted from our function.

Regarding the quantity of seeds (SQ), there is no data on the amount used per hectare. However, as mostly local seeds are used, the prices of grain and seed move together, eliminating one possible source of change in seeding rate. Furthermore, the amount (some 15 kg/ha for maize and 10 kg/ha for sorghum) is so small that it represents an insignificant fraction of total harvest. Swings in harvest are therefore unlikely to influence retention for seeding. For these reasons, the SQ variable will be assumed to be a constant, and drops out of our function.

We are now in a position to re-state, in a much simplified form, a crop production function that can be estimated empirically.

$$Q = f(AH, R, F, AE)$$

This is tested using OLS under the following functional specifications:

$$Q = a + b_1AH + b_2R + b_3F + b_4AE + u \qquad \text{(linear)}$$

$$Q = a + b_1AH + b_2R + b_3F + b_4(AE)^2 + u \qquad \text{(quadratic)}$$

$$Q = a * AH^{b1} * R^{b2} * F^{b3} * e^{b4AE} * u \qquad \text{(exponential)}$$

where

a = the intercept

b_i = coefficients to be estimated (i = 1,...,4)

e = the natural logarithm

u = a stochastic error term

For all equations and both crops, the number of years with observations is 17.

In a first step, the seasonal versus monthly rainfall variables, and the fertilizer vs. the nutrient adjusted fertilizer measurement were tested using a linear free stepwise OLS. After choice of variables, the estimation method was stepwise OLS with forced entry of the variables AE (AE^2 in the quadratic function), AH and F in accordance with the production function specified above. The program was left free to choose the monthly rainfall variables of highest significance, with a cut-off point of 15 percent significance of the parameter estimate. Only the best performing regressions in terms of explanatory power values are presented here.

3.2.4 Results

First, the aggregated seasonal rainfall variable performs very poorly in explaining crop production. Using a stepwise selected set of monthly rainfall data is very effective in raising the explanatory power. Therefore, only monthly rainfall variables are shown below. These are signified by e.g. "RSEPM" to denote rainfall in September weighted for its distribution across maize growing districts, as explained above.

Second, the gross measure of fertilizer use performs much better than the nutrient adjusted fertilizer variable. This is contrary to the theoretical expectation, but may possibly be explained by incorrect calculations of net nutrient content. The graph of the latter variable

exhibits some jumps that are difficult to explain. Only regressions using the gross fertilizer measure are reported here.

Third, the three functional forms gave the following results in summary format.

Table 3.5 Maize Regressions

A. Linear form:

$R^2 = 0.89$ Adj. $R^2 = 0.82$

Variable	Parameter Estimate	Significance[7] Level
AE	0.476	
AH	0.240	
F	1.246	***
RNOVM	-0.576	***
RJANM	0.310	***
RFEBM	0.332	***

Durbin-Watson D = 2.185

B. Quadratic form:

$R^2 = 0.92$ Adj. $R^2 = 0.86$

Variable	Parameter Estimate	Significance Level
$(AE)^2$	-0.046	
AH	0.233	
F	1.396	***
RSEPM	0.246	*
RNOVM	-0.512	***
RJANM	0.350	***
RFEBM	0.264	**

Durbin-Watson D = 1.945

7. Significance on the 10, 5 and 1 percent level respectively is signified by *, ** and ***.

C. Exponential form:

$R^2 = 0.85$ Adj. $R^2 = 0.79$

Variable	Parameter Estimate	Significance Level
AE	-0.125	
LNAH	0.646	**
LNF	0.445	**
LNRNOVM	-0.511	***
LNRMARM	0.364	***

Durbin-Watson D = 2.357

A comparison of the explanatory power can be made between the functional forms. The adjusted R^2 corrects for differences in the number of parameters that entered the equation. However, the dependent variable in the exponential function is the **logarithm** of production and not production as in the two others. Therefore, a "converted" adjusted R^2 has to be calculated by taking the anti-log of variables. The "converted" adjusted R^2 = 0.89, which makes the exponential form slightly superior to the others in terms of fitting the data.

The erosion variable coefficient has the expected negative sign in two functions, but is insignificant in all three. This is the most important result: there is **no statistically significant trace of a negative erosion impact on maize**, for the time period studied.

It could be argued that the coefficient, while insignificant, still represents the best available estimate. However, its size is implausible, as shown by the following example. Disregard for a moment all other variables in the production function and write the obtained result from the geometric form:

$\ln Q = - 0.125 * AE$

and, taking anti-logs and substituting for AE = E * t,

$$Q = e^{-0.125 * E * t}$$

and inserting the value for erosion rate, we get

$$Q = e^{-0.125 * 20.42 * t} = e^{-2.55 * t}$$

Looking for the relative rate of decline now, we get:

$$Q_0 = 1$$

$$Q_1 = 0.08$$

which implies a drop of 92 percent in one year - a quite implausible figure. This confirms the choice to neglect the estimated coefficient.

A problematic result is the negative and significant coefficient for rain in November. It is not likely that rains have been so excessive as to damage crops, as this is only in the beginning of the season, and considerable rainfall is important for the germination of the plants. A possible explanation is that excessive November rains in some years of low production, actually caused by other adverse events (later drought, hail, frost, pests) could result in low harvest. This example might fit the harvest of 1975 and 1976, when production was unusually low and November rains unusually generous.

Proceeding to sorghum, the results are shown in the table below.

Table 3.6 Sorghum Regressions

A. Linear form:

$R^2 = 0.77$ Adj. $R^2 = 0.67$

Variable	Parameter Estimate	Significance Level
AE	-1.411	
AH	0.637	**
F	0.294	
RNOVS	-0.340	***
RMARS	0.196	***

Durbin-Watson D = 1.766

B. Quadratic form:

$R^2 = 0.84$ Adj. $R^2 = 0.74$

Variable	Parameter Estimate	Significance Level
$(AE)^2$	-0.050	
AH	0.520	**
F	0.388	
RNOVS	-0.363	***
RJANS	0.281	***
RFEBS	0.159	*

Durbin-Watson D = 1.433

C. Exponential form:

$R^2 = 0.78$ Adj. $R^2 = 0.67$

Variable	Parameter Estimate	Significance Level
AE	-0.002	
LNAH	1.030	***
LNF	0.515	**
LNRNOVS	-0.314	**
LNRJANS	0.316	**

Durbin-Watson D = 2.031

The sorghum regressions are parallel to the maize regressions in several ways. The exponential function gives the best fit to data, with a "converted" adjusted $R^2 = 0.77$. Similarly, the erosion coefficient is negative - in all cases here - but statistically insignificant even on the 10 percent level. Considering the size of the AE coefficient, it amounts to a 4 percent annual decline in production, still a figure that is likely to exaggerate the impact of erosion.[8] The counter-intuitive result for November rains also remains.

Before we go on to interpret the result in terms of economic impact, there are a few econometric tests to consider in order to judge whether the classical assumptions behind the use of OLS are fulfilled. If they are not, this has potentially serious impacts on the properties of the OLS estimators. The themes of autocorrelation, heteroscedasticity, multi-collinearity and non-stochasticity of exogenous variables will be considered in turn.

First, consider the aspect of autocorrelation. For the maize regression, a formal test places the D-statistic in the inconclusive region, i.e., we cannot formally conclude whether or not to reject the null hypothesis of absence of autocorrelation. However, this problem is dependent on the fact that there are so few observations and a comparatively large number of regressors.

8. See the discussion on micro level evidence of erosion impact in chapter 5.

Informally, it is apparent that the D-statistic is very close to 2. This is the general indicator of zero autocorrelation (Johnston, 1984, p. 315). In addition, a re-run of the regression with the highly insignificant AE variable dropped, reproduces the other results closely, while allowing a formal and conclusive test indicating no autocorrelation. As for the sorghum regression, the D-statistic allows us to immediately conclude that the null hypothesis of no autocorrelation cannot be rejected.

Second, there is the aspect of possible heteroscedasticity. A non-rigorous but easy test was applied here. The squared residuals were plotted against all the variables included in the equation. "Eye econometrics" was used to make the qualitative judgement that there was no apparent cause for concern on this point.

Third, consider the aspect of multicollinearity. Johnston (1984, p. 250) gives some guidance as to what constitutes "a problem" in this respect. First, a condition index in excess of 20 signals a problem and should direct the attention to the proportions of the sampling variance of each parameter. Second, coefficients with proportions of the sampling variance in excess of 0.5 may have been adversely affected by collinearity.

Of particular interest here is the parameter estimate for the AE variable. For the exponential maize (sorghum) regression the condition number associated with the AE parameter estimate is 6.1 (6.2) and the maximum variance proportion is 0.01 (0.01). The conclusion is that multicollinearity does not appear to be a problem related to the estimation of the AE coefficient.

A fourth aspect to consider is the assumption underlying OLS estimation that explanatory variables are non-stochastic. This aspect is problematic. The areas from which production is measured vary from year to year. One year a particular field is in under fallow, the next year another one. If this variation is entirely random, it should not greatly affect the estimates as the average characteristics of land in use would remain balanced. However, to the extent that marginal, severely eroded areas are systematically taken out of production first in years of a low number of hectares harvested, the land

base over which we attempt to measure the impact of erosion changes over time in quality as well as quantity.

The problem must be admitted, but there is at least some reason to think that it is diminishing. The trend for less crop land under fallow is noticeable, which gives a more and more constant land base under utilization across years. Another point is that the crop land of Lesotho is not utilized on a well functioning market where marginal units from a national perspective of productivity are also marginal from the household aspect. On the contrary, most households with land own very little land, and the decision of cropping versus fallow is not a marginal one. The extent of erosion is likely to be an insignificant factor in that decision as compared to availability of draught power and labour for plowing and cash for inputs.

It is of interest to discuss what the statistical implications are of this problem. Kmenta (1986, pp. 334-340) discusses three types of cases. The first is when the stochastic explanatory variable (X) and the disturbance term (u) are independent. This poses no problem for OLS estimation. The second possibility is that X and u are contemporaneously uncorrelated. In this case the desirable properties of the OLS estimators hold only asymptotically. The third case is that X and u are neither independent nor contemporaneously uncorrelated. This is the most serious case and implies that the least squares estimators of the regression coefficients are not even consistent.

With such potentially serious effects on the validity of OLS estimation, it would be desirable to test for which case of the three discussed above that applies. However, no such test is available. Plotting the residuals from the estimated regression against the explanatory variables will not do, as the estimates of the unobservable u terms are derived in a manner that should make them independent of the X-variables. Thus, we are left without any rigorous way of assessing this problem, and must rely on a qualitative judgement based on the arguments above.

To conclude on the point of tests for the validity of OLS estimation, autocorrelation, heteroscedasticity and

multicollinearity do not appear to pose problems, whereas the stochastic nature of the area harvested might do so.

3.2.5 The District Level Analysis of Erosion

The application of USLE to Lesotho is controversial, and cannot be expected to yield very accurate results in terms of tons per ha soil lost. On the one hand, the estimates do not include gully erosion. On the other hand, the MoA (1988b) estimates do not allow for deposition of eroded material. Hence, there are biases in both directions and the final deviation is unknown.

However, these estimates are used in this context for a specific purpose where only the **relative** - not the absolute - magnitude of district-wise erosion is of key interest. Seen in this light, they constitute at least a reasonable basis for our statistical tests.[9] In any case, they constitute the only available data base there is.

The MoA (1988b) study is used here to analyze the relationship with yield in two steps. First the trend value (time coefficient) is derived for each district through a regression of yield on time. District crop data are only available for the (harvest) years 1974-1989. This is is used in a second step to regress the trend value of crop yield per district on the erosion rate for 1988 (the only year for which district erosion data are available). The result of the first step is shown in the table below. Figures in bold type denote significance on at least the 10 percent level.

9. This judgement is supported by Lennart Strömquist (Professor of Physical Geography, personal communication). However, it is admitted that also the relative magnitudes are to some extent biased by the exclusion of gully erosion. Gullies appear most severely in the districts of Mohale's Hoek, Mafeteng and Quthing (Bernt Rydgren, Division of Land Use Planning, personal communication).

Table 3.7 Yield Trend Values and Erosion Rates

District	Trend Coefficients			Erosion (kg/ha)
	Maize	Sorghum	Wheat	
Berea	-2.7	-20.1	**-31.64**	18.24
Butha-Buthe	**-51.9**	-33.6	3.87	25.84
Mafeteng	**-28.6**	**-46.5**	**-25.31**	16.20
Maseru	-5.3	-19.0	**-37.06**	10.55
Leribe	1.2	-18.6	21.46	37.06
Mohale's Hoek	**-43.3**	**-42.8**	-5.00	22.42
Mokhotlong	-18.4	-25.6	**-48.23**	6.10
Qacha's Nek	-19.2	20.2	**-29.27**	17.49
Quthing	-14.7	-33.2	-19.77	19.02
Thaba-Tseka[10]	-25.1	-17.8	-18.35	16.24

The results of the second step regressions are given below. The model is simply:

YTREND = a + b * E

where

YTREND = yield trend coefficient

a, b = parameters to be estimated

E = district erosion in ton/ha

The results of the district level regressions are shown below.

10. Note that Thaba-Tseka was created as a new district in the agricultural year 1979/80, and therefore has a shorter time series than other districts. In addition, it confuses the picture as it was created out of three other districts. It is impossible to correct for this change during the period of analysis.

Table 3.8. Yield Trend Regressions

Maize:

$R^2 = 0.0$

YTREND = - 19.7 - 0.058 * E

Sorghum:

$R^2 = 0.0$

YTREND = - 27.1 - 0.032 * E

Wheat:

$R^2 = 0.91$

YTREND = - 63.4 + 2.4 * E

For maize and sorghum yield, the t-tests for significance show that the null hypothesis of **no significant influence of erosion** on the time trend for 1974 - 1989 cannot be rejected. For wheat, the coefficient is positive and significant, which is a counter-intuitive result.

The only reasonable conclusion is that other forces than erosion have dominated the determination of yield over time. E.g., fertilizer input and rain distribution may have been more favourable for wheat in the districts that also happen to have the most severe erosion. Conversely, the districts with the most negative development for wheat yield may be the districts where the declining wheat production has been most marginalized. These hypotheses have not been tested as a part of this research.

3.2.6 The Economic Impact of Crop Losses

The econometric macro level approach has not given a firm basis to stand on in terms of estimated crop production losses due to erosion. However, some degree of negative

impact is certain to exist, as the average soil loss in Lesotho is clearly above the rate of formation of new soil (MoA, 1988b; Schmitz and Rooyani, 1987).

In principle, micro level plot studies could provide a more precise understanding of the soil loss damage function (Stocking, 1985). However, there are no such studies available for Lesotho. As discussed in chapter 5, more or less comparable data from other countries must be used to delineate a reasonable interval of production damage relevant for Lesotho. These estimates point to productivity losses of fractions of a percent rather than whole percentages per year for a rate of soil loss such as the average for Lesotho: approximately 20 ton/hectare per year on crop land (MoA, 1988b).

Even though precise estimates cannot be provided, it is of interest to illustrate the economic importance of a reasonable guesstimate of the rate of erosion-induced losses in crop production. This is illustrated here using three types of measures. First, there is the net loss in income for one particular year, due to erosion in the preceding year. This will be referred to as the Net Annual Income Loss (NAIL). This is only a first step, to illustrate the most immediate loss.

The second measure is the Net Discounted Income Loss (NDIL). This is the present value of the future, possibly infinite stream of NAILs, discounted with a real social discount rate. The NDIL can be used for purposes of national income accounting adjustments, as suggested by Repetto et al (1989). The size of the NDIL indicates the loss in potential income due to one year's depletion of one component of the natural resources base.

The third measure takes into consideration not only the capitalized value of one year's erosion, but also the cumulative impact of successive years of erosion over time. This is referred to as the Net Discounted Cumulative Income Loss (NDCIL). This measure is suitable when considering investments in land rehabilitation, as they will generally counter the accumulation of erosion during a succession of years.

Returning to the first measure, the NAIL for a particular crop is calculated as:

$$NAIL = (P - MC) * dQ$$

where

P = economic price per ton
MC = marginal production costs per ton
dQ = production loss due to soil loss in tons

Declining grain production in Lesotho will have to be substituted by increasing imports. The economic price of one ton of maize or sorghum lost due to erosion is the willingness to pay for the alternative import that is thereby displaced. On the margin, this can be approximated with the market price for the grain.

The selling price from Coop Lesotho depots in 1990 was approximately M 490 per ton of white maize and M 400 per ton of sorghum (Mohale's Hoek Coop, list of prices). The additions for transportation costs vary considerably across the country. In the case discussed in chapter 5, it is estimated that transportation costs bring up the price to approximately M 540 for maize and M 460 for sorghum. However, the areas relevant in that case are in the Lowlands and comparatively accessible. While most people live in the Lowlands, some areas have considerably higher transportation costs. In the absence of local price surveys, a guesstimate is that M 560 and M 480 per ton reflects an average local price of white maize and sorghum respectively in 1990.

The existence of considerable food donations to Lesotho as "free" resources raises a complication for economic pricing. However, it can be argued that this support is counted as part of a "country frame" of politically determined financial support to Lesotho. Thus, there is also a real opportunity cost for Lesotho for this "free resource", i.e. the value of alternative foreign aid funded resources displaced. While not entirely convincing, the assumption will be made here that food aid carries a full opportunity cost equal to the market value of grain. An upper bound economic price for

production lost is at least captured when making this simplified assumption.

The assumption here is that the total amount of imports of goods and services to Lesotho is not affected by erosion. Imports are pushed to the limit of what the economy can bear, both with and without soil loss induced production decline. Thus, the government revenue from the Southern African Customs Union will be unchanged, and no adjustment is made to the price of imported grain on this account.

A decline in production also entails savings. The main component is labour. It is assumed here that losses in productivity will not induce additional costs for e.g. fertilizer to compensate for this negative impact. This appears realistic, given the perception among Basotho farmers of erosion as a relatively minor agricultural problem (Gay, 1984; Mashinini, 1988; Wilken, 1982) unlikely to invoke much of a management change by itself. The saving in marginal production costs (MC) is derived from the labour requirement functions discussed in chapter 5. The equations for the traditional management option are used, as being most representative of Lesotho agriculture. The equations can be written in the following manner:

$$L = A + b * Y$$

where

L = labour requirement in days per hectare;

A = a fixed labour day requirement for the preparation of land, seeding, etc. of one hectare, regardless of yield level;

b = coefficient

Y = yield in kg per hectare.

Empirical estimates discussed in chapter 5 have shown that the labour requirement equations for the two major grain crops can be written as:

Maize: $L = 52 + 0.055 * Y$

Sorghum: $L = 55 + 0.063 * Y$

It is assumed that the number of hectares cultivated is constant with respect to erosion, so that non-yield related labour costs are fixed in the agricultural sector as a whole. This implies that for every ton of maize lost, there is a labour saving of 55 days, and similarly for sorghum, a saving of 63 days. Priced at the opportunity cost of M 2.5 per day[11], the labour cost saving for less harvesting-threshing-winnowing work amounts to approximately M 138 and M 158 per ton of maize and sorghum respectively. The saving in other costs, such as grain bags and local transportation costs is minimal, and could be included by rounding off to M 150 and M 170 respectively.

The physical loss of production (dQ) is not calculated from the estimated production functions, as the coefficients pertaining to erosion are statistically insignificant and furthermore implausible in size. Instead, the micro level evidence discussed in chapter 5 is used, and a 1 percent annual production loss, ceteris paribus, due to erosion is postulated. Most likely, this is an overestimate, but will serve the purpose of illustration.

The "annual" loss calculated here is for a "hybrid year" in the sense that production data are based on the average production during 1969/70 plus 1973/74-1988/89, while prices are from 1990. The results are shown in the table below.

Proceeding to the Net Discounted Income Loss (NDIL), we know that the erosion during year $t = 1$ does not only damage crop production at the end of the period 1, it damages production in $t = 2 \ldots T$, where T signifies the end of agricultural production in the case without

11. See chapter 5 for a discussion of the opportunity cost of labour in Lesotho.

erosion. The break-even point for traditional crop production in Lesotho - in the no-erosion scenario - is probably far enough in the distant future to be approximated with infinity.

A further aspect is that the net loss may vary over time, because of real price changes. Time trends for prices on maize and sorghum are discussed in chapter 5. The conclusion is that the Lesotho official millgate white maize price shows a significant positive trend for the past couple of decades in the past. The sorghum price has shown some, but not very significant decline in the past couple of decades. The simplifying assumption is made here that the relative prices of grain and labour input will change as to balance each other. Thus, the net loss per ton of grain is assumed to remain constant over time.

The Net Discounted Income Loss (NDIL) due to soil erosion is the next measure to consider. This measure could act as a signal to decision-makers that the natural resource capital is depleted with this amount due to current crop land erosion. Discounting has been done using a rate of both 1 and 10 percent, consistent with chapter 5. Using an indefinite time horizon, we can write:

$$NDIL = NAIL/r$$

where

r = the real social rate of discount

As for the accumulated impact on production of erosion, this is calculated as Net Discounted Cumulative Income Loss (NDCIL). A finite time horizon is assumed here, as this measure is of use when relating losses to investment costs for soil conservation measures with finite durability. Formally, this measure is:

$$NDCIL = \sum_{t=1}^{T} (((P-MC) * dQ_t)/(1+r)^t)$$

where

$$dQ_t = k * t * Q_{avg}$$

k = the constant relative decline factor (0.01 here)

t = time index in years (t = 1, ... 50)

Q_{avg} = the average crop production for the 17 years included in our data set.

The table below summarizes the results in terms of the three measures introduced here. It also shows some comparative (1989) figures for domestic factor incomes (GDP = M 942 million), gross national product (GNP = M 2077 million) and national disposable income (NDI = M 2273 million) for Lesotho (BoS, 1990b), in order to put the losses in some macro economic perspective.[12]

Table 3.9 Net Losses due to Lower Maize and Sorghum Production

	Losses (M mill.)	Share GDP (%)	Share GNP (%)	Share NDI (%)
NAIL	0.6	0	0	0
NDIL(10%)	6	1	0	0
NDIL (1%)	57	6	3	2
NDCIL(10%)	59	6	3	3
NDCIL(1%)	520	55	25	23

In summary, the table shows the qualitative impressions that the immediate loss (NAIL) is negligible in the macro economic comparisons made. The present value of discounted future losses of a single year's soil loss (NDIL) take on noticeable values if the lower discount rate is used, otherwise not. The most interesting from a policy perspective is the cost of cumulative land degradation (NDCIL). Over a 50 year horizon, this amounts

12. By definition, GDP at factor prices + indirect taxes - subsidies = GDP at market prices + net factor income from abroad = GNP + net transfers from abroad = NDI. (BoS, 1990b).

to a marginal loss of national income if the higher rate of discount is used. However, if the lower rate of discount is used, the cumulative future losses are quite substantial also from a macro economic perspective.[13]

Thus, even a seemingly undramatic decline of crop production of 1 percent per year due to soil loss accumulates forcefully and irreversibly over time to significant income losses. This example serves merely to highlight the magnitude of the potential losses. More detailed cost-benefit calculations must follow to determine the net worth of specific measures to prevent this decline from continuing.

The perspective applied in the quantitative analysis has been explicitly confined to crop land. This is certainly not because other soil loss impacts are thought to be negligible. However, available data only permits some qualitative comments to be made at this point.

Erosion on rangeland is physically slightly less per hectare than soil loss from crop land: approximately 18 ton/ha/year as compared to approximately 20 ton/ha/year for crop land. In absolute magnitude, soil loss from crop land is more substantial than from crop land: 23 million ton as compared to 15 million ton. (MoA, 1988b). There are no estimates of its economic impact for the Lesotho economy. Nor are there, to our knowledge, any micro level studies in the country that could be used for simple inferences. While off-site economic impacts of each ton of rangeland and crop land soil loss may be very similar, the on-site economic impact need not be proportional to the physical amount of soil lost.

As for off-site impacts of erosion, there are no estimates available of their economic impact. Studies from other countries cannot be readily applied to Lesotho. Previous to the on-going Lesotho Highlands Water Development Project - discussed below in this chapter - there were no major dams suffering from siltation. Water quality is affected, but the availability of drinking water from pumps is high in rural Lesotho. Recreational damage, which is often a considerable part of the off-site damage costs estimated in e.g. studies in the USA,

13. Chapter 5 contains a discussion on the relevant discount rate for Lesotho.

appears limited in the case of Lesotho. A sweeping assessment is that off-site impacts are probably far less important in Lesotho than on-site and directly production-related impacts.

Returning to an overall assessment of the calculations made here, the role of agriculture and soil conservation needs to be put in a more general perspective. If social resources can be utilized more efficiently in raising income in other sectors, such as industry, education, infrastructural development, tourism, and so on, they should be the target of development efforts rather than soil conservation projects. If development in these sectors is successful enough, there is little need to worry about land degradation from a macro economic perspective. In the terminology discussed in chapter 2, it would be a case of depletion of soil rather than land degradation as an economic problem.

Our survey of the economy of Lesotho at the beginning of this chapter casts doubts on the ability of sectors other than mining in South Africa to provide for substantial future incomes for a broad segment of the population. Real GDP per capita rose by only 4 percent when comparing the year 1989 to 1980, and exhibited an erratic pattern of ups and downs in between (Central Bank, 1990a, p. 7). This shows an aggregate ability for income growth in spite of losses of the natural resource base in the past decade. However, fluctuations are strong between years, and comparisons sensitive for the choice of time span.

Two additional considerations speak for particular attention to the natural resource base for agriculture. First, the **irreversibility** of the deterioration coupled with uncertainty about future capacity to buy food from abroad. Second, there is the **income distribution** aspect. People dependent on subsistence agriculture constitute a bottom segment of the income pyramid in Lesotho (BoS, 1988, p. 45).

This section has reviewed some quantitative evidence of land degradation in Lesotho and its economic significance. We go on to consider whether there are any particular features of the economy that indicate substantial deviations between private and social rationality in utilizing land. Possibly, such deviations

could be addressed through policy reforms that could serve to lower the rate of degradation and diminish its impact on the national economy.

3.3 Markets, Public Policy and Land Degradation in Lesotho

In chapter 2, an analytical framework was established, taking the neoclassical model of the Pareto optimal economy as the point of departure. Deviations from that model were grouped in two broad categories: market failures and government failures. In this chapter, this framework is used in order to analyze the case of land degradation in Lesotho.

While the basic structure of this chapter will be similar to the previous one, there is clearly a need to adjust the attention devoted to each item depending on its relevance for Lesotho. Section 3.3.1 contains a discussion of externalities and the incompleteness of risk and futures markets in relation to land degradation. Section 3.3.2 goes on to consider public policies affecting land utilization. This concerns both the intentional soil conservation efforts and the impacts on land use of other policies.

It is impossible to draw a sharp empirical line between the results of "markets" and "policies" as all markets are affected by policies and vice-versa. Thus, there is inevitably some overlapping in the discussion that follows.

3.3.1 Markets and Land Degradation

Externalities

Land in Lesotho is by tradition and law regarded as a national heritage the husbandry of which is vested in the King (Land Act, 1979). By tradition, the right to allocate land has been delegated to chiefs. It is important to distinguish between rangeland and crop land in this respect. The former is characterized by common property management, often taking on the features of an open-access regime. The latter is characterized by private usufruct rights during the cultivation season, but less strongly upheld rights to crop residues in the season after harvest and before planting. The limited questions dealt with here is whether there is reason to

believe that externalities constitute an important problem from a land degradation point of view.

Consider first **rangeland**. As noted in chapter 2, communal property regimes do not necessarily imply resource degradation any more than private management, provided that impacts external to the smallest decision-making units (heads of households) are internalized by management rules pertaining to the whole community. However, the characterization of the livestock sector in Lesotho, given in section 3.1, indicates that externalities are pervasive in the management of rangeland in Lesotho. The National Environmental Action Plan goes as far as stating that:

> "The most widespread and evident environmental problems of Lesotho are directly or indirectly related to overgrazing." (NEAP, 1989, p. 17).

A tradition of private usufruct rights to **crop land** has been established, and the right of inheritance codified by law (Land Act, 1979). Regulations issued to elaborate the Land Act of 1979 specify that land can be revoked if not properly managed, e.g. by failure to combat soil erosion. However, examples of this being implemented are not known. (McAuslan and Michanek, 1988).

The subjective feeling of security of long-term utilization appears to be firmly established among farmers (Mashinini, 1989). Thus, the impact of erosion on yields on crop land should in principle be internalized by the household. However, there are reasons to think that this may not be done appropriately.

First, there is the issue of whether or not the farmer realizes the true impact of erosion. It is interesting to note that preoccupation with erosion among Basotho farmers appears to be low (Gay, 1984, Mashinini, 1988; Wilken, 1982). Strong and immediate impacts on agricultural production are felt from e.g. drought, cutworm, frost, hail and lack of draught power. The impact of erosion is slow and not very visible.

Gully erosion is the exception in terms of visibility, but this constitutes a minor part of overall soil loss. A strict delineation between different types of erosion is

not possible, but according to the National Resource Inventory (MoA, 1988b) the share of gully erosion was estimated to less than two percent of the total.

As discussed in section 3.2, it is difficult to discern the impact of erosion even using multiple regression analysis and a data base not available to the average Basotho farmer. There appears to be a case for government conducting research and providing extension services in relation to this issue. However, one should be cautious against the attitude that "experts know but farmers don't". Lack of precise information does not by necessity imply that the impact of erosion is **under**estimated by Basotho farmers. In fact, ignorance prevails at all levels, and there is currently no set of precise, quantitative erosion-production functions to bring to the farmers.

Second, land degradation spreads between cultivated units. On the often steeply sloping lands of Lesotho, this is an apparent problem. A poorly conserved field upstream can damage crops and conservation works downstream. All off-field erosion externalities will not be negative, as nutrients and organic matter is transported from a higher to a lower field. However, this commonly causes disruption in lower field due to flooding, waterlogging and silt deposition. As rains in Lesotho are intensive during the cropping season, and much less so when the soil is bare, the negative impact on crops under growth is likely to dominate. Still, spontaneous "Coasean bargaining" with fees being paid to compensate for, or to avert potential damage, is not documented to have occurred among farmers in Lesotho.

Third, there is an additional externality affecting crop land, linked to the use of grazing land. Although formally against the Range Management and Grazing Control Regulations 1980, communal grazing of crop residues after harvest is still common. This decreases the biomass recycled and leaves the soil without protective micro barriers against erosion.

Turning to the other side of the coin, the prevention of these externalities has a public good nature. Many farmers benefit from communally constructed waterways and cut-off drains protecting the lower watershed from

flooding. Policing of maintenance of soil conservation structures and of herding of livestock on crop land is another service that could be achieved by collective, extra-market action.

In part, this can be organized on a private level, and is likely to take place already. Social pressure can be applied for inducing better soil conservation upstream, although a financial payment is not involved. However, such a mechanism is unlikely to work upwards in the social ladder. Private policing of one's own field against trespassing livestock is possible, but is costly to organize on an individual basis. Private marketing of soil conservation works benefiting a whole catchment would run into difficulties of free riding. It would also be in conflict with land property rights tradition in Lesotho. These examples show the limitations of private market solutions.

To summarize this sub-section, externalities on **rangeland** is a key environmental problem in Lesotho. On crop land, **on-field** impacts should be internalized under existing property rights arrangements. The caveat is sufficient information, but there is reason to suspect that this is not efficiently supplied by the market. **Off-field** impacts and crop residue grazing cause externalities. While these externalities in principle could be internalized through decentralized bargaining, this is not observed to happen in Lesotho. There is at least a potential case for collective action to internalize these externalities. The final judgement depends on the balance between the costs of collective action and the benefits of the improvements achieved.

Futures and Risk Markets

The next potential market failure requiring discussion concerns futures and risk markets. To what extent can Basotho farmers capitalize on future returns to land improvement investments? To what extent can farmers spread their risks when investing in land improvements? To what extent are farmers constrained in raising resources necessary to realize investments? These are

some fundamental questions that form a background for this particular section.

The credit market in Lesotho can be divided in a **formal** part and an **informal** part. There is little evidence that the latter plays a significant role as a credit mechanism **between** households, although there is of course some lending, particularly in-kind. The "village moneylender" is not a common feature of Basotho rural life. This appears to be naturally linked to the very substantial cash transfers from migrant workers to own households.

A striking feature of rural Lesotho is the degree of monetarization. In fact, the Household Budget Survey in 1986/87 showed that more than half of rural households quoted migrant mineworker remittances as their **main** source of income. Only 16 percent quoted subsistence farming as their main source of income, while 11 percent stated cash cropping or livestock raising on this point. (BoS, 1988, p. 44). The conclusion is that cash resources are available to rural Basotho to an extent which is unusual in African farming.

Turning to the formal credit market, this can be sub-divided into the banking sector and cooperative credit associations, to be considered in turn.

The Banking Sector

Apart from the Central Bank of Lesotho, there are three commercial banks in Lesotho: the private Barclays Bank and Standard Bank, and the state owned Lesotho Bank. The latter engages in agricultural loans to a limited extent. This is also the special task of the public Lesotho Agricultural Development Bank (LADB).

Liquidity is generally high in the banking system. There is a considerable influx of regulated remittances from mine worker in the RSA. The so-called "Deferred Payment Scheme" stipulates that 60 percent of the Basotho miners' wages must be deposited directly with the Lesotho Bank (Central Bank, 1990b). They can then be withdrawn when the account holder has returned to Lesotho. Demand for investment credit is low, in spite of low real interest rates. The average real rate charged to borrowers for the

period of 1973-1989 was less than 2 percent, with a level of 4-5 percent in more recent years.[1]

The LADB is of particular interest for the purposes of this chapter. It was created by Government Order in 1976 and commenced operations in 1980. A major obstacle in its operations have been the limited accessibility: only one branch was operational - in Maseru - as the external support was initiated. However, the LADB is expanding, and the network has grown to 7 branches and 14 agencies at the end of 1989 (Central Bank, 1990a).

The LADB was supported from the start and up to December 1988 by the Agricultural Marketing and Credit Project, sponsored by IFAD (International Fund for Agricultural Development). The project was to be implemented jointly with Coop Lesotho Ltd - the parastatal dominating agricultural input and output trade - and the Ministry of Agriculture. The project faced substantial difficulties because of its design and institutional bottlenecks.

Political pressure on Coop Lesotho to manage far more depots than economically justified, inefficient decision-making, stock pilferage and high overhead costs all contributed to poor financial performance of the Coop throughout the project period. LADB has also shown a declining financial performance since 1984. The most successful aspect of the project was seasonal lending for agricultural investments, reaching some 6 thousand farmers. Collections as percentage of total loans due peaked at only 57 percent in 1988. (Lindberg, 1987; FAO, 1989). This implies a substantial part of the risk was carried by the creditor.

The Government of Lesotho has now instructed LADB to charge commercial rates for their loans, and the October 1990 rate for seasonal loans was 21 percent per annum. Demands for collateral are somewhat informal. Usually, a deposit of 25 percent of the loan is required. However, this requirement is waived at times. Livestock is not taken as collateral as the risk of theft is considered very high. Defaults are frequent during bad harvest years, but legal actions against bad debts are very rare. In general, supply of agricultural credit far exceeds

1. This is calculated from the Central Bank (1983, 1986, 1990a), CFI (1979) and IFAD (1986).

demand. (Mashapha, LADB, Mohale's Hoek manager, personal communication).

The Cooperative Credit Sector

Lesotho does not have a strong, indigenous tradition of cooperatives as business ventures. The first documented attempt to introduce the cooperative movement in the country goes back to 1931, when a group of local traders joined to obtain better wholesale purchasing prices. This, and later attempts starting in 1946 and 1948, were not successful. A more lasting impact has been made by the Cooperative Credit Unions, formed by Roman Catholic Priests, starting in 1961. These are the only kinds of cooperatives that function well even today. (Mpona and Traerup, 1986).

During the 1980s, DANIDA has extended funding for a Cooperative Development Center. The executing agency is the Danish Cooperative Center. As a part of this support programme, a survey team visiting all ten districts and 121 societies, concluded that about 2/3 of all registered societies were dormant. Credit Unions were more advanced than other Cooperatives. Members of other societies do not often attend meetings and the staff members were found to lack basic skills in book-keeping, auditing and administration. Some Societies were completely dominated by one person, running the cooperative as a private enterprise for individual benefit. There was little evidence of government support. The team recommended the establishment of a national apex organization for cooperatives, and transferral of ministerial units for management and bookkeeping to the Lesotho Cooperative College. (LCC, 1986). A national apex organization was registered in 1989: the Lesotho Federation of Cooperatives. However, it is currently not operational. (Buhl-Nielsen, Cooperative Adviser, personal communication).

The most recent statistics on cooperative societies (LCC, 1987) shows the following break-down of "active" societies by type:

Table 3.10 Cooperative Societies in Lesotho

Type	Number	Members	Loans (000 M)
Credit Unions	64	26482	958
Farmers Soc.	62	7059	95
Thrift & Credit	30	2266	63
Handicraft	30	1826	4
Poultry	9	2960	<1
Multi-purpose	6	737	95
Marketing	5	1196	NA
Consumer	3	653	33
Tractor owners	2	52	3
Horticulture	1	120	NA
Total	212	43351	1284

Source: LCC (1987). Note: Total loans may not add due to rounding. NA signifies data Not Available.

The figures for registered membership can be assumed to be reasonably reliable, but figures for loans given are to be regarded as very unreliable. Even on paper, the cooperative movement is insignificant on a national scale, and the level of activity of registered members is often low. The qualitative conclusion is that cooperative societies do not provide a common and efficient channel for rural credit in Lesotho.

Is Collateral a Problem?

It is often assumed that the lack of collateral due to the land tenure system in Lesotho is restrictive to the taking of loans. In contradiction, Mashinini (1988) concludes his survey of farmer interviews with the statement that lack of collateral is **not** the problem in relation to development of cropland. A counter argument to his conclusion appears at first hand to be that only 27 of his 78 respondents claimed that their land could be used as collateral. However, more importantly, only three households had actually attempted such an arrangement. Two of them succeeded. As for the large majority of the respondents, they "did not know" (41 percent) or "had no

need to use fields as a security for credit" (32 percent). In general, the farmers in the surveyed area in southern Lesotho do not appear interested in taking loans for agricultural improvements.[2]

Another issue pertaining to the availability of credit is gender. Married women in Lesotho are legal minors, but banking practice to some extent permit women to open bank accounts on their own and to pledge the deposits as collateral without the authority of their husbands (Kaphwioy, 1990). This gives her the possibility of investing in land improving measures independently of an absent husband, or if she is widowed. However, the fact that only 10 percent of the beneficiaries of the IFAD Agricultural Marketing and Credit Project were women (FAO, 1989) implies that traditional lending custom still prevails in many areas of Lesotho.

As discussed in section 3.2 and in chapter 5, crop yields are very unreliable in Lesotho. This implies the need for insurance against crop failures. However, there is no such insurance scheme available in Lesotho. The reasons for lack of insurance markets in terms of moral hazard, adverse selection and high transaction costs have already been discussed in chapter 2. The relevance of these constraints are confirmed by the author's interviews in Lesotho.

As for **futures** markets, investments in land improvements cannot be directly sold, as there is no commercial market for rural land. However, importance may be attached to the knowledge that heirs will benefit from increased production due to soil conservation on crop land. This appears to be a weak force, judging from the lack of spontaneous conservation work invested.[3]

The Land Act of 1979 makes it legally possible to lease out land, opening up a cash flow possibility for the farmer who improves his asset through conservation investments. However, the necessary legal framework of detailed regulations is still not established, and

2. The financial profitability of such investments is discussed more in chapter 5.
3. Again, this may be because of lack of information about the impact of erosion, not because of a lack of consideration of future generations' welfare.

uncertainty hampers this encouraging force to invest in land fertility (McAuslan and Michanek, 1988; FAO, 1987; World Bank, 1990a).

As for investments in livestock, the future market is definitely there. Private trading makes up the bulk of business. Thus, the problem in this sector is not related to the absence of futures markets for livestock, but to the management of the common property basis for livestock - the rangeland - as discussed previously in this chapter.

Another investment category of environmental importance is trees. Fruit trees are popular around the homestead, where future benefits can be reasonably certain. However, planting on terrace banks is not an attractive proposition as thefts and cattle browsing of seedlings diminish private returns. Investments in fuelwood trees on the range are a case where individual control is limited. The traditional custom, codified in the "Laws of Lerotholi" (n.d.) make provision for the chiefs to allocate land for the growing of trees in a manner that ensures long-term security and even inheritance. However, the discretionary power of chiefs is substantial, and individual rights are often difficult to uphold in practice.

In summary, the rural areas of Lesotho are incorporated in the monetarized economy to a considerable extent, with more than half of the rural households relying **primarily** on migrant remittances. This constitutes a considerable informal source of capital, in principle available for agricultural investments, if so desired. The average farmer in Lesotho has limited access to the formal credit market. The cooperative credit sector is insignificant, and the regular banking structure is highly concentrated to towns. Real rates of interest on loans have been, and are still to an extent, low. The evidence gathered in this case study casts some doubt on credit supply being an important constraint to land improvement investments. Crop cultivation is a high risk enterprise in Lesotho, but a formal insurance market has not developed to handle this problem. However, some risk is absorbed by credit institutions, which very rarely proceed to take legal action in the numerous cases of default.

3.3.2 Public Policies and Land Utilization

This section starts by considering the active and purposeful measures taken by government to promote land improvements. It goes on to discuss other, perhaps unintended, impacts on land utilization due to actions, or lack of actions, in other policy areas.

3.3.2.1 Policies to Counter Land Degradation

The most obvious aspect of public policy to be considered in relation to land utilization, is the specific actions taken to counter land degradation. In the case of Lesotho, this contains two major elements: range and crop land policies respectively. In the former case, the element of soil conservation has been a rather subordinate element, and so inextricably intertwined with other aspects of range management policy, that the issue is dealt with under the heading of "property rights" below. The policy to counter land degradation on crop land has had a more separable component of specific land rehabilitation measures, and is discussed in this section.

Lesotho has a long history of government involvement in soil conservation on crop land. The colonial authorities attention was brought to the problem already in the 1930s, when a period of drought, followed by heavy rains had a dramatic impact on soil erosion.[1] A commission authored the famous "Pim Report" (Pim, 1935) which outlined the soil conservation policy later pursued.[2]

The plan was to cover the most erosion-affected areas of the crop land with terraces, buffer strips and contour furrows in ten years. The main responsibility for this rested with central government, and there was little involvement on the part of farmers apart from the

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1. The impact of single, powerful rainstorms can be dramatic. Rydgren (1990, p. 63) reports from a study of the 1985/86 rain season that on poorly conserved cultivated fields, a single rainstorm accounted for 80 percent of the total suspended sediment loss that season.
2. The report has a much broader content and was instructed to: "... inquire into the position of Basutoland from the financial and economic points of view ... " in general (Pim, 1935, p. vi).

recruits in the labour gangs. In fact, most farmers showed a negative attitude to conservation, and baptized buffer strips "makorota" ("field reducers"). Conservation structures were sometimes intentionally destroyed and planted trees were chopped down.

The Pim report was vigorously implemented in the 1930s and 1940s, but there was a break in activities during the Second World War. Activities were taken up again after the war and by the late 1950s, most of the crop land in the Lowlands had been covered with mechanical conservation measures. This was followed by a period of increasing attention to maintenance. In 1958-1966, public relations were emphasized, but political conflict was a major impediment. (Nobe and Seckler, 1979; Chakela and Cantor, 1989).

After independence in 1966, the efforts of actively involving farmers were increased and supported by external donor funding. Area-based conservation projects continued to promote mechanical rather than biological conservation measures. Sometimes heavy earth-moving equipment was used. Foreign donations were largely uncoordinated and subject to the preferences of the donors rather than Basotho farmers.

Several large programmes have been launched by donors to promote better land management. The World Bank's first project in this sector was the Thaba Bosiu Rural Development Project, dating back to 1973. It was not successful, but had not even finished before a similar, more extensive programme was embarked upon: the Basic Agricultural Services Programme (BASP).

BASP was initiated with an agreement reached in 1978, and was intended to increase the income of some 150 thousand families in the cultivable areas, at a cost of USD 26.4 million. BASP was concluded in 1985 after serious setbacks and after spending less than 60 percent of its budget. The World Bank evaluation concluded that the economic rate of return had been negative. It pointed to a number of reasons for failure: the lack of an appropriate input package that could be recommended to the farmers, Government disinterest, poor donor coordination, lack of competent personnel and the

generally unfavourable conditions for crop production in Lesotho. (World Bank, 1987b).

An extensive review of past soil conservation efforts until the late 1970s (Nobe and Seckler, 1979) brings out the lack of continuity among projects and lack of financial accountability for using scarce resources. It is suggested that:

> "... the ready availability of high levels of donor funding in recent years has led to too many poorly designed and executed projects." (Ibid., p. 174).

Later assessments are no different. Chakela and Cantor (1986, p. 1) summarize their review of the history of soil and water conservation in Lesotho, by stating that:

> "In spite of the tremendous human and financial resources which have been devoted to conservation during the last 50 years, the actual progress made towards limiting erosion in order to increase production has been extremely limited."

Current Government Policy contained in the Five Year Plan indicates a shift in emphasis from mechanical to biological conservation measures, including tree planting. The policy document specifically pertaining to soil and water conservation, still considered to be in force is Moa (1972?). This brief, mimeographed document appears to be unknown even to many professionals working with conservation in Lesotho. The basic approach outlined is one of (a) belief in detailed conservation planning, (b) consultation with the land-managers when making the final decision recorded in the conservation plans and (c) conservation as an integrated element of agricultural production.

In actual practice, major governmental attention in the agricultural area is currently devoted to the Food Self-Sufficiency Programme (FSSP). The aim of the programme is to increase production of cereals. There is no explicit component of soil conservation in the FSSP. It is a capital intensive operation requiring substantial

government subsidies. For these two reasons, it will be discussed below under the heading of public spending.

In conclusion, past conservation efforts have been poorly documented, but to the extent that evaluation is possible to undertake, efforts have been largely unsuccessful in securing a stable land base for Lesotho agriculture and in raising yields according to project expectations. Later conservation efforts are better integrated in agricultural development schemes, but the major government supported programme in this field lacks an explicit conservation component.

3.3.2.2 Property Rights

This section will discuss property rights, first as they affect distribution of agricultural resources, particularly land, in general, second pertaining to rangeland management more specifically. The communal nature of rangelands poses particular problems affecting the degree of land degradation.

Distribution of Agricultural Resources

There is an increasing number of landless people in Lesotho, often also without livestock and formal employment. This group is likely to increase in the future. The physical land base is slowly eroding and subject to some urban encroachment, and the range is already overstocked. Formal employment is not expanding rapidly enough, and even being reduced in some activities as a result of the structural adjustment programme. The dynamics are illustrated by the following table.

Table 3.11 Access to Livestock and Crop Land by Rural Households (percent)

Category	1970	1980	1986
Land & livestock	50	47	47
Land only	37	32	28
Livestock only	12	6	8
No land or livestock	1	15	17
Total	100	100	100

Source: World Bank (1987, p. 61).

The main impact of this skewed distribution from a land utilization perspective is that a bottom strata is emerging which can only access crop land or livestock through leasing arrangements. Their personal discount rates are likely to be quite high and time horizons short. Crop land production and livestock utilization will be geared towards maximizing current rather than sustainable net benefits. Marketed fuels will be unaffordable for this group, which by necessity will turn to the "free" supplies of shrubs in the countryside.

The legislation pertaining to land property rights is dispersed and difficult to interpret. The customary laws of Lesotho date back to the 19th Century and are compiled under the heading of "The Laws of Lerotholi". These laws are a mixture of codified custom and colonial regulations. They give legal support for mechanical conservation works including tree planting and stipulate contour plowing and protection of vegetation in gullies. The responsibility of supervision lies with the chief and the village headmen.

Another important piece of legislation in relation to soil conservation is the Land Husbandry Act (1969). This Act applies to land used for crops or livestock rearing. It gives the Minister of Agriculture wide-ranging powers to prescribe how land should be divided between crops and grazing, what species should be cultivated, conservation measures, number of livestock permitted and so on. An Agricultural Officer shall determine annually the carrying capacity of each grazing area, and chiefs shall

divide areas into sections for rotational grazing. An official permit is required for the use of a grazing area, and this is to be renewed annually. The cultivation of grassland is also prohibited by this Act. While the legal framework is there, detailed regulations that would contribute to making the legislation an operational and effective tool for good land husbandry is lacking (McAuslan and Michanek, 1988).

The Land Act (1979) preserves the basic principle of land as the property of the Basotho Nation, held by the state as the representative of the nation. The Act divides land[3] into (a) land held under allocation and (b) land held under lease.[4] In rural areas, land is allocated by the Land Allocation Committee (LAC), established in each chieftainship. The local chief is the chairman of the LAC, ex-officio. As McAuslan and Michanek (1988) point out, later regulations (1987) make no mention of the position of the chief, but provide for elections at a pitso (public village meeting) with all adult inhabitants as eligible participants.

The Land Act and later Regulations do not specify on what grounds land should be allocated, whereas the Laws of Lerotholi state that land should be allocated "fairly and impartially". The Regulations stipulate a review of all allocations every three years to determine whether or not rights should be revoked. Reasons for revocation could be overgrazing, lack of soil conservation measures or lack of cultivation of arable land for more than three years. There seems to be consensus among observers in Lesotho that these regulations are rarely, if ever, invoked.

Furthermore, the Minister of Agriculture can declare any area a selected agricultural area. Any leases or allocations in such an area are automatically revoked or terminated (Section 44). While this provision has not been used, it appears to create some uncertainty as to long-term usufruct rights. To the extent that the Land Act is known among farmers, this provision will hamper

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3. The Land Act does not explicitly deal with grazing land.
4. The legislation concerning leases is currently not clear, as conditions referred to in the Land Act have not been published. This renders the Act partially inoperable.

the willingness to incur costs for long-term investments in land improvements.

Informal sub-leasing of crop land is rapidly growing (McAuslan and Michanek, 1988). The traditional form of leasing is share-cropping on a 50/50 basis, but several other forms of leasing are also observed (FAO, 1987). These arrangements lack a legal framework, making both parties vulnerable to the other's refusal to honour the agreement.

As for the farmers own perception of tenure security, Mashinini (1988) provides empirical evidence from a survey in the Brakfontein area, adjacent to the project area presented in chapter 5. The survey is based on a random sample of 118 households. Farmers appear to perceive a very high degree of security in their use of crop land: 90 percent of the respondents said they expected to use their fields for the rest of their lives. Almost everyone believed that their land would be passed on to their children. Mashinini concludes:

> "It is clear, for conservation planning, that the present land tenure does not discourage implementation and maintenance of conservation works on **cropping** land." (Ibid., p. 13, emphasis added).

In summary, the **legislation** pertaining to conservation of land **is rigorous but generally not implemented.** It is often lacking subordinate legislative regulations and provisions for effective enforcement. By custom, supported by law, there is a feeling of long-term security of usufruct rights to crop land, and of the rights of heirs to succeed in this endeavour. Commercial leasing arrangements are emerging, but are not provided legal support. Sale of agricultural land is prohibited.

Property Rights and Rangeland

Public policy aims at influencing property rights to range land in three major aspects[5]: re-adjudication of cattle posts, the promotion of Range Management Areas and

5. The full livestock management programme adopted by government also includes culling and animal exchange programmes, animal health and marketing promotion measures. These aspects are left aside here.

the introduction of national grazing fees for livestock (LNLTF, 1990; MoP, 1987). These will be discussed in turn.

The National Rangeland Adjudication Programme has three components. The first is a cattlepost inventory to determine the pattern of transhumance and quantities of livestock involved. The second is the determination of "appropriate" cattlepost users, and the third is re-adjudication of cattlepost grazing rights to specific groups of users. This process was initiated in 1989, but is severely hampered by the fact that inventories can only be carried out in January to April, when livestock are actually located at cattleposts, and by the lack of qualified staff. It is expected that only the inventories will take five more years to complete. Obviously, that is only the easiest part of this specific programme.

The Adjudication Programme is a corner stone in defining strict property rights necessary for the introduction of more advanced range management. A key tool in this respect is the establishment of Range Management Areas (RMAs). As of 1990, four RMAs exist in Lesotho, covering some 130 thousand hectares.[6] There are plans to create five new RMAs in the next five years. (LNLTF, 1990).

The success of the RMA programme is under dispute. The World Bank, (1986) reports that a major USAID funded project to promote the establishment of a local grazing association has been unsuccessful. Government support has been "modest" and local authorities do not control the situation well. However, the Lesotho Highlands Development Authority (LHDA) apparently regards the experience of the Sehlabathebe RMA as a successful undertaking, worthy of replication (LHDA, 1990d).

Lawry (1987a) reports that some 50 percent of Sehlabathebe livestock owners were members of the Grazing Association (GA) in 1985, only two years after the project was introduced. It is clear that this GA has provided a tangible, immediate benefit to its members by excluding other communities from their historical use rights. All areas cannot be "winners" in this respect.

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6. Assuming 80 percent of the country to be "rangeland", (World Bank, 1986) the RMA share is about 5 percent of the total.

Furthermore, a membership survey has revealed very little faith in the long-term administrative sustainability of the Association, if external support is withdrawn. Lawry concludes that:

> "In Lesotho, the social and economic conditions for effective local cooperative action in range management are not usually present. Grazing associations lack the social authority to enforce even modest controls." (Ibid., p. 6).

The institution of a national grazing fee has long been suggested by foreign observers, particularly by USAID and the World Bank. It is now incorporated in such key national documents as the Five-Year Plan Development Plan (MoP, 1987) and the National Environmental Action Plan (NEAP, 1989). The latter was adopted after considerable and decentralized consultation within Lesotho, including the hierarchy of chiefs.

The implementation of the grazing fee is outlined in a plan from the Livestock Policy Implementation Committee (LPIC, 1991). Fee collection is to be done by Village and Ward Development Councils. It is acknowledged that an extensive training programme will have to be carried out in order to make these institutions functional with respect to the implementation of the grazing fee system. Registration of all livestock must be undertaken in every village. The recommended fee levels are M 3 per head of cattle, M 0.5 per head of sheep and goats and M 5 per head of equines. It is also recommended that at least 50 percent of the collected funds should be used for livestock related development projects.

A policy option that appears almost entirely neglected in the public debate in Lesotho is the introduction of either locally determined grazing fees or marketable grazing permits.[7]

The following points can summarize the sub-section on land property rights in Lesotho. Property rights to **crop land** provide for inheritance and secure usufruct rights. This should secure the farmer of the benefits of investments in land improvements on crop land. However,

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7. These options are analyzed in a separate paper (Bojö, forthcoming).

this is hampered by the lack of legal framework for leases that could place land utilization in the hands of households with better resources of management. Legal constraints to sale of land also hampers the emergence of a more efficient allocation of land. Thus, security may not be the problem, but an efficient matching of household resources and land holding probably is.

The lack of enforced communal property rights on **rangeland** makes the regime approach[8] one of "open-access", and encourages overstocking by privately rational farmers. Ongoing work to re-adjudicate cattlepost grazing rights will take many years still to complete. The experience of Range Management Areas have shown them to be crucially dependent on external, donor-funded support. The introduction of a national grazing fee is under way with emphatic donor support. The obstacles for implementation are severe.

3.3.2.3 Population Policy

It is estimated that the population of Lesotho will grow by approximately 2.6 percent per year until the end of this century (World Bank, 1990b). This implies a doubling of the population in approximately 27 years. In spite of this prospect, Lesotho lacks an explicit population policy (NEAP, 1989; CPDO, 1989).

A draft policy is contained in CPDO (1989), which is based on a national workshop specifically held for the purpose of designing such a national population policy. The document was never formally adopted by a statutory body, and much of the content was reiterated in yet another workshop on population policy in August, 1990. The draft contains a broad range of goals pertaining to key areas such as migration, mortality and fertility. While some of the suggestions are merely statements of laudable activities, others are quantified and sometimes given a timetable. Thus, the agenda is laid out, but the

8. The existence of at least temporary rents in the livestock system, documented by Swallow et al (1987), indicates that a stable open-access equilibrium is not reached. Prices and range conditions fluctuate strongly and a time series analysis would be needed for a more definite characterization.

crucial issue remains that no politically responsible body has formally adopted this ambitious attempt.

A quantitative goal of reducing the population growth rate from 2.6 percent to 2.0 percent per year was officially declared as a part of the Second and Third Five Year Plans. However, no target date was given, nor have the means for achieving this goal been specified. (CPDO, 1989). The goal is not reiterated in the latest Five-Year Plan, the fourth in order (MoP, 1987).

There are plausible explanations for the Government's reluctance to face the issue of population growth. The Catholic Church is the strongest in Lesotho, and has clearly condemned artificial contraception as immoral. Another significant church in Lesotho, the Anglican, sees the use of contraceptives as an acceptable component of responsible parenthood. (MOHSW, 1979). The Evangelical Church is known to take a position less articulately negative than the Catholic, but nevertheless, "Family Life Education" is resisted. As the Catholics and Evangelists together control a majority of the schools in Lesotho, this is a formidable resistance to the educational element of a population policy.

The major family planning agency in the country is the Lesotho Planned Parenthood Association (LPPA). It receives support from the International PPA and USAID. LPPA has four branches with 2-3 clinics each. There are some 25-30 Field Educators attached to these clinics. The Private Health Association of Lesotho is a Christian organization running several hospitals which also provide family planning services.

The "Community Based Distribution" programme was initiated in late 1990 as a joint venture between LPPA and the Ministry of Health. Village women are trained to act as local agents for family planning services. Currently, the use of contraceptives among fertile women is in the area of 5-10 percent, according to the 1986 Census and several more specific studies that have been made. Abortion is legal in Lesotho, but only under restrictive conditions such as rape, incest or "contraceptive failure". In the latter case, proof of usé must be submitted. There are no statistics even on legal

abortions. (Guindon-Zador, Coordinator, Family Health Initiatives II Project (USAID), personal communication).

The status of women, and particularly their education, is often assumed to be strongly correlated with fertility. The educational status of women in Lesotho is comparatively strong, as boys often serve as herd-boys when they are small, and later go to the mines with very little schooling. Adult literacy is 60 percent for females but only 40 percent for males (BoS, 1989, p. 3). However, married women are legal minors, and must generally have their husband's or another male relative's support for important decisions. Male resistance to family planning is strong, as contraceptives are seen to induce "immoral" sexual behaviour.[9]

Implications for Land Degradation of a Growing Population

The implications of population growth for utilization of crop land, rangeland and fuelwood resources will be discussed here, as will the possibilities to alleviate environmental pressure through migration.

A growing population and already small holdings of **crop land** per rural household implies more and more landless people, a group which has now reached the size of about one quarter of the **rural** households (NEAP, 1989).

Figures in the literature differ on the size of average holdings and definitions are often not clear. Taking a rounded figure of 300 000 ha from Mop (1987, p. 9) as the approximate size of land "suitable for cultivation", this can be compared with different categories of demographic data. The 1986 population census registered a total de jure population of 1 577 thousand, and a de facto population of 1 447 (Ibid. p. 11). With 84 percent of the "population" residing in rural areas (Ibid., p. 17), and assuming this can be applied to both concepts of population, the rural population was 1 325 thousand (de jure) and 1 215 (de facto) in 1986. A figure of 5 persons per "rural household" is given in MoA (1986, p. 3), but it is not clear whether this applies to de jure or de facto members. Applying this figure in both cases, we arrive at 265 thousand rural households (de jure) or 243

9. The role of women in Lesotho is dealt with in detail by Khabele and Shale in CPDO (1989).

thousand rural households (de facto). Dividing the land between them equally, the average holding of land among rural households would be 1.13 ha and 1.23 ha respectively. Finally, assuming that 25 percent of the rural households do not hold land (NEAP, 1989), the average figure becomes 1.51 and 1.65 ha per land-holding rural household.

Cultivation has already been pushed onto marginal, often steeply sloping lands. To the extent that extra-marginal cultivation occurs into grazing land, it is met with several obstacles: miserable yields, formal illegality and strong opposition from cattle owners utilizing an already overgrazed range. Thus, this avenue is not in general open to the increasing rural population.

Theoretically, the heirs of the family field(s) could decide to sub-divide them informally in accordance with the Land Act, 1979. However, this is not a viable strategy for the average household. The minimum individual requirement of food grain, as given by FAO/WHO, is 131 kg of maize, 47 kg of wheat and 25 kg of sorghum (LHDA, 1990c, p. 28). Taking the average (1969/70 plus 1973/74-1988/89) national yield of maize as 866 kg/ha and the corresponding figures for sorghum and wheat as 824 kg/ha and 734 kg/ha respectively, one arrives at a minimum acreage per five-person household of 1.2 ha. Assuming post harvest losses of 15 percent (LHDA, 1990c), the figure is raised to 1.4 ha. This is close to the national average available per land-holding rural household, as was shown above.

The requirement discussed is only to sustain a bare minimum, and additional food would have to be grown to complement this meagre diet. Thus, further sub-division of crop land to cater for new families is not a generally viable strategy, unless migrant remittances can make up for the shortfall in subsistence production.

Furthermore, no consideration has been given here for the need to **fallow** the land in order for it to recover. This is another aspect of the impact of population growth; the land under fallow is likely to diminish. Statistics on cropping intensity are limited, but from 1976/77-1985/86 a share of 6-24 percent of the arable land has been reported as fallow (BoS, 1986). As shown more in detail

in section 3.2, the tendency during the late 1980s is that planted crop land increases in area. The relationship is not simply one of population increase driving this development, as the 1970s saw a decrease in area planted. Other forces, such as the number of migrants, their real wages and the timing of rainfall also have a role to play.

The physical impact of a decrease in fallow should be an initially increased rate of erosion, as the land is left bare from cultivated crops, but gradually a natural vegetative cover will be established. This is likely to be grazed, but poorly conserved rangeland is still less affected by erosion than poorly conserved crop land.[10]

As discussed in chapter 2, population growth could provide a stimulus for improved crop management and intensified use of inputs. As discussed in section 3.2, this transformation of agriculture in Lesotho has been slow in forthcoming, and it has at any rate been insufficient in terms of meeting the growing demands for food. This has been met by increasing imports and food aid instead.

A second aspect of population growth in rural areas is the increased pressure to invest in **livestock** rearing. There are still small rents to be captured there (Swallow, 1987), at least temporarily. Livestock is a relatively inflation-safe storage of wealth, and awards social prestige to the owner. As grazing is basically one of an "open-access" regime, the limiting factor is the means to invest in livestock. Further additions to the national herd will aggravate the overgrazing problem with an obvious implication for land degradation. As shown in section 3.1, livestock numbers have increased, reaching record levels in 1986, after which figures are not available. As with cropping intensity, this is not simply a function of population. Migrants' remittances will affect the ability to invest in livestock and temporary droughts will increase the death rate among the already malnourished animals, forcing the stocking rate down.

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10. Detailed comparisons of soil erosion from plots with various types of vegetation are available in Temple (1972).

A growing population also implies a growing consumption of livestock products such as meat. Induced price changes are unlikely to be substantial, because of the dominance of the RSA market. In order to be net consumers on the livestock product market, new households will have to derive their additional income from some other source. As discussed above, the options in the Lesotho economy are very limited. Thus, there will be a desire among many new households to become net producers of livestock, which entails building up new herds of animals first, with obvious implications for land degradation.

A third aspect of an increasing population, is that it will demand more **fuelwood**. The national average residential energy consumption is currently met in the following way:

Table 3.12 Residential Energy Consumption (percent)

Fuelwood	31.3
Shrubs	29.9
Cow dung	18.9
Coal	8.9
Crop residues	5.3
Paraffin	5.3
Electricity	0.5

Source: LHDA, 1990e, p. 3.

The marginal rural household cannot afford electricity or coal, but may consume some paraffin. Access to cow dung and crop residues will be limited. This leaves fuelwood and shrubs to provide the bulk of the energy demand. The energy demand per capita (1984) was about 18 thousand MJ (LEMP, 1988). Assume that 95 percent of this has to be met using fuelwood and shrubs. Planted trees and shrubs yield 16 thousand MJ/ton (LHDA, 1990e), which implies a marginal per capita consumption of almost 1.1 ton. The current annual population growth is about 44 thousand persons per year. Their additional requirement would be about 48 thousand tons of fuelwood per year.

Looking at the supply side, we can expect that one hectare of (well-managed) woodlot can produce

approximately 4.5 tons of fuelwood. (Ibid.). This would require an area of about 11 thousand hectares per year to be planted, only to keep up with annual additional demand. This can be compared with the **accumulated** achievement of the only major afforestation programme in Lesotho: 6 thousand hectares of woodlots planted since 1973 (LEMP, 1988).

This calculation is very simplified, and does not take into account technical development, such as with fuel-efficient stoves, and substitution of fuels. Still, taking such factors into consideration, the Lesotho Energy Master Plan (LEMP, 1988) projects a severe and increasing shortfall of traditional fuels, if no public action takes place. Therefore, a massive national woodlot programme is recommended, with 7 500 hectare to be planted per year. As Green (1990), has pointed out, this is based on the unrealistic assumption of plantations being well-managed. Real plantations will be much less productive and planted spaciously to allow for grazing. Realistically, the suggested targets will not be met, and the result will be an aggravated denudation of the landscape of Lesotho.

A fourth aspect of population growth is the option to **migrate** to the cities or abroad. The cities of Lesotho grow rapidly: some 7 percent per year (CPDO, 1989), but the cities already have a large number of unemployed (LFS, 1990). The formal sector does not offer a viable employment opportunity for a sufficient number, and government employment is likely to go down under the IMF adjustment programme. Domestic migration therefore provides limited relaxation of the environmental pressure that a growing population exerts.

Migration to South Africa is arranged primarily as mine employment through The Employment Bureau of Africa (TEBA). As discussed above, the number of mine workers has remained high (CB, 1990b). Future prospects are uncertain, but the number is not likely to increase to an extent where considerable environmental pressure is taken off the rural areas of Lesotho.

While the foregoing is valid for the number of **miners**, there is an important addition to make about migration of Basotho in general to South Africa. Current legislation

is quite restrictive in granting access to the labour market in the RSA. Access in temporary and limited to working males, and families are forced to stay behind in Lesotho.[11] If the political reforms under way in South Africa resulted in the abolition of this restrictive system, a much broader wave of migration might take place.

In conclusion, the current economic and political situation leaves the rural "surplus" population with few attractive options. Most of them are forced by necessity to contribute to increased land degradation through some mixture of marginal cultivation of crop land, livestock rearing aggravating overgrazing, and fuelwood gathering denuding the landscape.

3.2.2.4 Price Regulation

Lesotho is an economy with little **domestic** price regulation, compared to many other African countries. The price of foreign exchange is left to the international market via the fixed parity rate versus the South African Rand. There are minimum wages, but these are not really implemented in the local, rural economy, and are not an obstacle to e.g. hiring labour for conservation works. Interest rates are also basically determined by the proximity to the RSA market, rather than Lesotho Government regulation. From the perspective of land degradation, pricing of agricultural inputs and outputs are of particular interest.

With regards to agricultural inputs, the only price "intervention" is the publishing of a reference price for fertilizer. This is not legally binding, and only serves to inform the public of a basic supply price. The previous subsidy (30 percent off market price) on fertilizer was abolished in 1988. No other subsidies on agricultural inputs have been identified.

With regard to agricultural outputs, there are "gazetted" (fixed floor) prices for maize (grain and meal, sorghum (grain only) and wheat (grain and flour), and a reference price for beans. Prices for cereals are fixed one month

11. See Murray (1981) for a detailed description of the legislation pertaining to work in the RSA.

before the harvest, and retained for 12 months ahead. Anyone is free to buy and sell at prices not lower than the fixed prices. The price level is determined by the RSA prices, with adjustment for transport costs. (Mokotjo, Chief Marketing Officer, personal communication).

White farmers are by tradition well represented in the parliament of South Africa. Farmers still form a vocal interest group, but have recently lost some of their political clout. Afrikaners have gained ground in circles of industrial and financial markets, and have begun to form interest groups with opposing aims. Despite stated ambitions to decrease agricultural support, subsidies continued to increase in the 1980s. Credit subsidies have been offered since the 1930s for farming investments, including soil and water conservation. Marketing boards were established by the Marketing Act of 1936, and have been important channels for price support to the farming community. The Boards are dominated by producer interests and control the sale of nearly all farm produce. The only major products that are not price controlled are fresh vegetables. (Cooper, 1988).

The important impact of the RSA price regulation on Lesotho is that agricultural production is encouraged by the output price support given in the RSA. Given the prevailing management of crop land, this will tend to aggravate soil erosion. As noted in chapter 2, the impact on land degradation of a change in price may be ambiguous. Higher prices encourage more intensive cropping and cultivation of marginal land, but also investments in soil conservation become more profitable. In the case of Lesotho, there are very few signs that farmers spontaneously undertake conservation measures on crop land or rangeland. Therefore, the impact of output price support in the RSA is likely to be negative from a Lesotho land degradation aspect.

The role of Coop Lesotho is a focal point when discussing agricultural inputs and outputs. The Coop strongly dominates the market for fertilizer, seed, and bags, and is also the official agent in buying crops from farmers. There is currently a move to privatize Coop Lesotho, as well as other parastatals (the abattoir, dairy etc.) in the agricultural sector. This is supported by the Lesotho

Agricultural Policy Support Programme (LAPSP). The programme is funded by USAID and is sub-divided into a livestock management reform component[12] and an input distribution reform component. The latter essentially means the development of an open and competitive market for the supply of agricultural inputs, including the privatization of Coop Lesotho. LAPSP is a USD 15 million programme with strict ties between actions and financial rewards. The first transfers have already been made in response to Government declarations such as MoA (1989):

> "Government is ... committed to open and competitive markets for the supply of agricultural inputs in Lesotho."

Regarding forestry, there are two cases of price intervention. First, the sale of tree seedlings from government nurseries is subsidized. Second, there is an artificially low price on fuelwood from publicly established woodlots. The actual production cost from a Government woodlot has been estimated at approximately M 78 per ton. This exceeds considerably the selling price of M 34.62 per ton or M 22.50 per m^3. (LHDA, 1990e). The impact of these subsidies is twofold. First, the demand for seedlings and fuelwood is increased. Second, private or communal alternative sources of supply are effectively undercut. The net direct impact is a larger volume of sales than in a free market situation, but at a financial cost which leaves repercussions in the rest of the economy.

The provision of free veterinary services (World Bank, 1986) encourages further investment in livestock and therefore contributes to overgrazing. However, all veterinary services are not free, and the direct cost of dipping and dosing is charged to the livestock owner. Regardless of pricing, the veterinary service is of very limited accessibility. Therefore, the existing subsidy on this point will not have a significant impact on the cost of most livestock owners.

The conclusion on this point is that Lesotho has few and hardly significant **domestic** price regulations affecting

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12. This component essentially aims at introducing a grazing fee and improving marketing facilities. This is discussed elsewhere.

land degradation and rehabilitation. However, there is an influence from the price regulation in South Africa, which upholds a higher output price level than on the world market. This encourages crop production also in Lesotho, with a negative impact on land degradation, given current management of crop and rangelands.

3.2.2.5 Trade Policy

There are two aspects to consider under this heading: (a) the trade policies pursued by other countries (b) the trade policy pursued by Lesotho.

Agricultural exports from Lesotho are very limited and consist mainly of mohair and wool. There is a limited scheme for the export of canned asparagus to the EC. The constraints are primarily on the supply side, and other developing countries would more readily capture increased market opportunities, should they arise due to decreased barriers to entry on export markets.

Lesotho's own trade policy is severely circumscribed by its membership in the Southern African Customs Union (SACU). This trade policy dates back to 1910, and was given its current shape through an agreement with the RSA, Botswana and Swaziland in 1969 (RSA, 1969). Within this framework, there are only minor trade policy measures specific for Lesotho. Cattle imports have been restricted since 1982, and only cattle for slaughter or of improved breeds are allowed to be imported (World Bank, 1986).

The importation of cereals and cereal products, fruits, vegetables and fresh milk is subject to temporary restrictions. Licensed traders are granted permits to import only to the extent that this will not interfere with the sale of domestic produce. This still leaves substantial room for imports from the RSA. At the time of harvest in Lesotho, permits are issued restrictively. The administration is centralized with regards to maize, but other commodities are handled by the District Agricultural Officers with the advice of the District

Marketing Officer. (Mokotjo, Chief Marketing Officer, personal communication).

Domestic price support for agricultural production in South Africa is coupled with import restrictions. Tariffs are generally low: R 4 per ton of sorghum and R 5.5 per ton of wheat.[13] There is no tariff on maize. (Hutton, 1989). These tariffs are minimal in relative terms. The selling price at a Coop Lesotho depot was about M 400 per ton of sorghum in 1990. A comparable figure for wheat is not available, but the price per ton of wheat has generally been some 30-40 percent higher than for sorghum (BoS, 1986), which corresponds well with the relative difference in tariffs. However, the important trade restriction for agricultural produce is a set of quantitative import restrictions (Board of Trade and Industry, 1990). Their general impact on Lesotho agriculture is the same as that of price raising measures discussed in the previous section: to encourage production and thereby aggravate erosion, given the prevailing management of crops.

The conclusion on this point is that non-SACU countries' trade restrictions do not significantly influence exports from Lesotho and by implication land utilization. Nor is there any possibility for Lesotho to deviate considerably from the rest of SACU in trade policy. Domestic trade barriers can temporarily create an artificial market space for local produce at the expense of consumers. However, the RSA producers still maintain a dominant position in fruit and vegetable markets, and imports of cereals and cereal products are substantial. The (potential of) low-cost smuggling sets a tight limit to the impact of Lesotho's import restrictions.

If SACU membership is so confining, what about leaving it? Lundahl and Petersson (forthcoming) have penetrated this issue in depth, and conclude that Lesotho is likely to remain inside the Union. The major reasons are that withdrawal would lead to a very substantial loss of government revenue.[14] Measures to compensate for the shortfall, such as increased tariffs, indirect or direct taxes would induce smuggling or migration. Secondly,

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13. R denotes the South African Rand. 1 Rand = 1 Loti = USD 0.39, average 1990 (EIU, 1991).
14. See the section on taxation below for details.

withdrawal from SACU would imply new trade barriers against exports to the RSA, which is by far the most important market outlet for Lesotho products.

3.2.2.6 Taxation

An overview of government revenues is given in the table below.

Table 3.13 Structure of Government Revenue (percent)

Year	87/88	88/89	89/90
Customs	53	52	53
Sales tax	19	20	21
Income tax	7	9	5
Company tax	3	5	4
Other	16	16	17
Total	100	100	100

Source: Adapted from Central Bank (1990a). Columns two and three contain preliminary figures.

The major source of income to government is taxes on international trade, channelled through the SACU common pool of revenue. This consists almost completely of tariffs on imports, as export taxes are negligible.

The most important domestic tax in terms of revenue is the sales tax. This was introduced in December 1982 at a rate of 5 percent on sales price. By 1986, it had increased to its current level of 13 percent. This rate coincides with the one applied in the RSA. There are substantial exceptions from the sales tax: all agricultural inputs and outputs are exempted (Mokotjo, Chief Marketing Officer, personal communication). Some items, such as alcoholic beverages, have a higher tax rate, and some, such as electricity, have a lower one,

but the general pattern is harmonization with rates applied in the RSA (EIU, 1990a).

Domestic income tax scales are progressive. However, migrant workers are not taxed in Lesotho. Since these are high wage earners among Basotho, this constitutes a considerable inequity. A change in this respect has been discussed but recent negotiations have stalled (World Bank, 1990a). On the other hand, agricultural income is not taxed either. While employees in the formal sector start paying taxes for income exceeding M 335 per month (Lesotho Government Gazette, Vol. XXXV, No. 59) at a rate of 15 percent (MoA, Accounts Division), there is no limit to the agricultural income that can accrue without tax. In fairness, such monthly incomes are not frequent for a farming household.[15]

Company tax is not an important source of government revenue. A study made in 1987 counted 1236 companies in Lesotho. Of these, 500 were registered as eligible for taxation, but only 264 had ever paid any taxes (Hill, quoted in Petersson, 1989). The government has committed itself to phasing out tax holidays, but also to lowering the current 37.5 percent corporate tax to 15 percent. Public sector enterprises will also be brought into the scheme. (EIU, 1990a).

The conclusion on this point is that the absence of taxation of agricultural production promotes this type of investment as compared to industrial enterprises which are taxed. As the effective tax rate for the latter is not very high, this is not a significant distortion. Mining income in the RSA is favoured by tax exemption as compared to domestic non-agricultural income. This affects land utilization indirectly to the extent that part of this income will be invested in livestock, but due to the property rights system, not in range improvement.[16]

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15. See section 3.1 for details on income levels.
16. It has been remarked that the absence of tax on migrant workers contributes to the alleviation of population pressure on the Lesotho countryside. However, the supply of willing migrant workers far outnumbers the demand, and would most certainly do so even with the application of domestic tax rates.

3.2.2.7 The Political Elites[17]

Lesotho is traditionally a monarchy with an elaborate chieftainship structure attached to it. The upper stratum of this structure is made up of 22 Principal and Ward chiefs. Nineteen of them are descendants of the previous monarch and founder of the nation: Moshoeshoe I and two of his brothers. A lower stratum of chiefs are the numerous area chiefs, under whom a headman is responsible for every village or village section. However, much of this traditional power has eroded as new party political structures started to penetrate the country, particularly since independence in 1966. (Murray, 1981).

The primary political force following independence in 1966 was the Basotho National Party (BNP), headed by Chief Leabua Jonathan. He gained the position of Prime Minister in 1966 after the country's first election. The next election was held in 1970. However, the people did not vote in favour of the BNP, and Jonathan suspended the Parliament. The one-party rule came to last until 1986, when Jonathan was toppled in a military coup. This was facilitated by the RSA, primarily through a strangling border closure that illustrated the country's vulnerability with eminent clarity.

At that time, South Africa had turned against Jonathan due to his outspoken criticism of apartheid, diplomatic ties with countries led by communist parties, and Lesotho's tacit tolerance of limited ANC activities. An armed hit-and-run expedition by South African troops into the capital of Maseru in 1982 naturally aggravated the conflict between the countries' regimes. Contributing to political dissonance was the alleged arming and training of BNPs Youth League by North Korean instructors. In January 1986, the military stepped in to ensure their position as the sole armed force in the country.[18]

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17. A detailed historical account of the political élites in Lesotho is given in Breytenbach (1975).
18. Interestingly enough, later in 1986, Lesotho and the RSA finally signed the Treaty regarding the Lesotho Highlands Water Development Project, after many years of fruitless negotiations. This project is of considerable importance in relation to water supply to the RSA. See the section on public spending below.

The new political leader to emerge in 1986 was Major General Justin Metsing Lekhanya. He headed a Military Council, advised by a partially civilian Council of Ministers. The previous King, Moshoeshoe II, has shared in the political leadership to a varying extent since 1966. He went into exile in March 1990, and was dethroned in November 1990. A new monarch was elected shortly afterwards. However, he is not likely to interfere with policy to the same extent. Work on a new constitution is under way, and elections have been announced to take place in 1992. However, traditional party politics are still banned. (EIU, 1991).

A centralized and inefficient administration was built up after independence. BNP membership was a considerable asset for advancement during Jonathan's rule, and equally disadvantageous under the new regime. Since 1980, there have been some moves to decentralize administration to the district level. Still, the current bureaucracy is poorly coordinated and financial discipline is lax. The Five-Year Plan frankly states that:

> "There is currently a strong and widespread awareness by the Government of the problems and deficiencies in Public Administration and Management." (MoP, 1987, p. 207).

This is a general problem, which also pertains to implementation of development projects and programmes, including those for land improvement. Murray (1981, p.19) claims that

> "... the history of development projects in Lesotho is one of almost unremitting failure to achieve their objectives."

Discussing the role of international aid organizations in relation to the domestic political structure and the bureaucracy, Ferguson (1990, p. 8) adds that:

> "Again and again development projects in Lesotho are launched, and again and again they fail; but no matter how many times this happens there always seems to be someone ready to try again with yet another

project. For the 'development' industry in Lesotho, 'failure' appears to be the norm."

Ferguson provides a detailed case study from Lesotho of the rationality of "failure". The Thaba-Tseka project did not succeed in its ostensible goals of transforming crop farming and livestock keeping in the new district. However, it did contribute to establish a new administration, better transportation links with the capital of Maseru, giving the Government a much stronger influence in the area than previously. In fact, a major reason behind the Government's support for the project was its desire to gain political control over areas dominated by the opposition, Ferguson claims.

It is well known - although poorly documented in detail - that livestock ownership is highly concentrated. Figures from 1975 show that 16 percent of the population owned 43 percent of the national herd of cattle (van de Geer, 1984, p. 55). The royal family, military officers, chiefs, businessmen and senior civil servants belong to the major livestock owners.[19] Hence, these powerful groups have a vested interest in the status quo of non-taxation of livestock. Therefore, political pressure to introduce grazing fees meets with great resistance, in spite of the substantial financial incentives provided by USAID.

The distribution of crop land is not extremely skewed among the landed. The major problem is the increasing group of landless. Resistance to the establishment of a land market is strong among the chiefs, as their traditional power rests very much on the authority to decide on crop land allocation (Murray, 1981).

The conclusion on this point is that the current leadership is based on military power, an attached government bureaucracy and a traditional structure of chiefs, only marginally modified by an emerging local rule under elected Village Development Councils. More fundamentally, this structure rests on the consent of the powerful neighbour. Any efforts to combat land degradation will have to function within the confines of the rationality of this political structure. Thus,

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19. This issue is usually dodged in reviews of Lesotho agriculture. World Bank (1987a) is an exception.

"failure" in terms of land improvement may still entail "success" in promoting political aims.

Furthermore, livestock ownership is concentrated to the most powerful segments of society. The major implication in terms of land degradation is that the political élites will effectively block any changes in common property management that would be a disadvantage to them as large livestock owners. Grazing fees are a case in point. Furthermore, the establishment of a free land market is in contradiction to the vested interest of the traditional structure of chiefs and their traditional privilege to allocate crop land.

3.2.2.8 Public Spending

The table below shows government expenditure by function for the latest years for which statistics are available.

Table 3.14 Government Expenditure by Function

Year	87/88	88/89	89/90
Defense, law & order	20	18	17
General services	18	16	12
Education	18	19	19
Debt service, transfers	13	16	29
Health	7	8	7
Agriculture	6	6	5
Other	18	17	11
Total	100	100	100

Source: Adapted from Central Bank (1990a). The last column is preliminary.

The first expenditure item includes public order and safety affairs. Counting only the more narrowly defined defence expenditure, the relative figure is reduced to 10-12 percent. This is comparable to the average recorded

for sub-Saharan Africa: 10 percent in 1985 (UNDP and World Bank, 1989).

Agricultural expenditure occupies a more modest position in the government budget, in spite of its importance in the GDP. The relative share of spending is comparable to the average for sub-Saharan Africa: some 7-8 percent for the first half of the 1980s (UNDP and World Bank, 1989).

A major undertaking in this sector is the Food Self-Sufficiency Programme (FSSP) which has been described as the largest single internally funded investment activity in Lesotho (World Bank, 1986). It is a capital intensive operation requiring substantial government subsidies. The aim of the FSSP is to increase production of cereals (maize, sorghum and wheat). Being a programme rather than a project, it has no definite closing date. The ambition is to achieve a recovery rate sufficient to support a revolving fund that will sustain the programme independently of donor input.

Money for FSSP activities is channeled through LADB and Lesotho Bank, through which farmers can apply for credit. The Ministry of Agriculture specifies the inputs packages that qualify for credit. There are two packages: the "intensive package" and the "minimum package". The former consists of a set of operations (ploughing, discing, planting, spraying and transport of inputs) and a set of inputs (fertilizer, seed, herbicides and cutworm and stalkborer bait). The "minimum package" has the same content, except the spraying and herbicides. FSSP is active in all districts except Mokhotlong, Thaba-Tseka and Qacha's Nek. The "minimum package" is recommended for the Mohale's Hoek and Quthing districts in the dry south. The Technical Operations Unit (TOU) executes the programme for the MoA. TOU is in itself the main contractor of services, but a number of private operators, both from Lesotho and the Republic are also used. (FAO 1987; Mabusane, FSSP Records Officer, personal communication).

Recorded FSSP activity in maize cropping peaked in 1982/83 at 19 percent of the national maize area. However, it had declined to about 10 percent in 1985/86 due to poor crop performance in the early eighties. In one year, the average maize yield was actually **lower** on

FSSP fields than the average national yield. Yield variance has also been higher for the FSSP fields than in traditionally cropped fields. (FAO, 1987). Later data are not available.

Currently, the major development programme in Lesotho is the Highlands Water Project (LHWP). The primary purpose of LHWP is to channel Lesotho water to an expanding industrial area in the RSA. The total cost is estimated to some USD 2.6 billion (1987 estimate) to be spent over a period of 30 years of construction of dams, waterways, roads and electricity lines. Lesotho is expected to find funding only for the hydropower component serving domestic needs, the bulk of the financing is taken care of by the neighbour. The projected water royalties for Lesotho were estimated (in 1983) to be USD 10 million in 1996, growing to USD 60 million in 2020. (Kratz, 1989). In addition, Lesotho saves the cost of import of electricity from the Republic. Improvements in rural infrastructure are substantial. However, local employment generation is very limited; some 4 000 workers are expected to be employed (Karlsson, 1986). Having started in 1987, the project runs about one year behind the schedule (EIU, 1990).

In terms of environmental impacts, primarily due to inundation, the most obvious points are the loss of 180 houses, 1424 ha of arable land, 3415 ha of grazing land, 1470 fruit trees and 5415 other trees (LHDA, 1990a). More generally, the previous river environment is transferred to a dam or lake environment. Fears have been expressed that the environment will receive less than its fair attention when such important commercial interests are at play. It has been claimed that the provisions of the LHWDP do not measure up to international standards of environmental law (McAuslan, 1987). However, it appears that subsequent environmental work has been quite ambitious in considering impacts on land. Several projects have been designed to deal with the adverse impacts of the water development project, and to counter the existing situation of continuous land degradation.

LHWP is administered through the Lesotho Highlands Development Authority (LHDA). It has developed a multi-faceted programme presented as a Rural Development Plan (RDP). This covers projects for the period 1990/91 -

2001/2, with an estimated cost of M 135.7 million (1989 prices). Projects concern animal husbandry and range management, community forestry, trout rearing, land use planning with the people, rural training, feeder roads, tourism development, water supply, rural sanitation, electrification and so on.

The prime beneficiaries of these projects are the 20 thousand people living in the two affected river catchments (Katse and Muela), some 9 thousand temporary settlers near LHWP work sites and residents in nearby communities amounting to some 10 thousand inhabitants. Particular attention will be paid to the 2 thousand people who lose more than 0.1 ha of arable land as a result of LHWP activities. (LHDA, 1990a)

The Animal Husbandry and Range Management Project entails the creation of a grazing association to manage the severely overstocked rangelands in the vicinity of the project (LHDA, 1990b). The Community Forestry programme of the LHWP aims to compensate for the loss of trees due to the project, to encourage agroforestry on farmland and conventional woodlots in gullies and other badly eroded land (LHDA, 1990d).

Another sub-programme concerns village infrastructure including electrification. However, the cost of rural electrification is prohibitive to most households. Therefore, the programme will only provide electrification for a few villages adjacent to the LHWP power stations. In each village, only some 15-20 households are expected to have sufficient income to pay for connection and running costs for electricity. (LHDA, 1990e).

The conclusion on this point is that government spending in several respects conforms to a pattern observed on average in sub-Saharan Africa, e.g. low spending on agricultural development as compared to this sector's contribution to GDP. Furthermore, this spending is not primarily directed at soil and water conservation, but to mechanization and more intensive use of agricultural inputs. By far the most important development programme in Lesotho - the Highlands Water Development Project - will have a strong impact on land utilization, but only

in limited mountain areas. There are also detailed plans to compensate for adverse environmental impacts.

3.2.2.9 Public Information and Decision-making

The basis for public debate via written media is well established in Lesotho. As mentioned above, adult literacy is high, particularly for females (BoS, 1989). There are very few domestic newspapers, but newspaper circulation per capita is six times higher than the average for sub-Saharan Africa. A limited selection of international press is available for the urban élite.

Radio ownership is widespread: 55 percent of all households own one (BoS, 1988, p. 40). Lesotho has one state-controlled radio channel, broadcasting mainly in Sesotho. There are radio broadcasts specifically directed to technical discussion on how to improve land utilization, produced by the Ministry of Agriculture (Green, 1990). Television is also state-controlled, and limited to half an hour of news broadcasting per day.

It may appear that information on land degradation and improvement would be entirely uncontroversial from a political point of view. However, this is only the case as long as the problem is defined in narrow technical terms. When it comes to introducing policy changes in order to deal with land degradation, there are only limited fora available in terms of institutions and media for free debate. Since party politics have been banned since the coup in 1986, no such political movement can articulate a programme for combating land degradation. However, the on-going political process might change the relevance of this point.

It should not be denied that there is already an open debate about natural resources degradation in Lesotho within other fora. The National Environmental Action Plan (NEAP, 1989) is one example of this. It was accepted after wide circulation within the administration and chieftainship structure of Lesotho. It is frank in discussing past policy failures and it contains some

succinct and controversial suggestions for policy changes.

The conclusion is that the current political situation limits free party political discussion on, among other things, policy reform pertaining to land utilization. However, this may change soon. The media are controlled by the government to a large extent, but independent newspapers and magazines are allowed. There is considerable room to openly discuss land degradation issues, at least in a narrow technical manner.

3.4 Summary and Conclusions

Section 3.1 presents Lesotho as a low-income developing country, geographically, politically and economically encircled by the Republic of South Africa. Roughly half of the Gross National Income is made up of incomes from migrant labour in the RSA. The Lesotho economy has an agricultural sector under relative economic decline. Its main elements are a livestock system under common property management approaching "open-access", and some crop production suffering from adverse climatic conditions and characterized by low-input, risk-avert management. There is also a small but dynamic manufacturing sector. Income distribution in Lesotho is quite skewed.

In spite of the long-standing concern with land degradation in Lesotho, there are, to our knowledge, no previous studies that attempt to quantify the macro economic impact of soil loss on crop production and productivity. In section 3.2 of this chapter, crop production and productivity performance is reviewed and related to plausible background variables. The estimation of a national level production function shows **no statistically significant impact of accumulated erosion on crop land on production** of maize and sorghum.

While the overall explanatory power of the national regression model is high, weaknesses have also been pointed out along the way. A major one is that the erosion variable is not available on a time series basis. In terms of the estimation procedure used - ordinary least squares - some tests have been performed for its validity. Autocorrelation, heteroscedasticity and multicollinearity appear not to pose difficulties, whereas the stochastic nature of the area harvested might reflect negatively on the properties of the estimators.

As for the district level analysis, we found no significant negative influence of erosion on the time trend of crop yields. Problems with using USLE data have been noted, but these estimates are the only ones available for Lesotho.

Given the often alarming accounts of the extent and speed of the erosion process in Lesotho, these results may

appear surprising. However, they do coincide with the low ranking of erosion among agricultural problems from a farmer's perspective that have been reported in several farmer surveys.

While we cannot derive direct estimates of the soil loss-production damage function from the econometric results in section 3.2, other evidence reported in chapter 5 is used to suggest an illustrative guesstimate. The macroeconomic significance of a postulated erosion-production relationship of 1 percent decline per annum is discussed, and measures of net economic loss are calculated. This is done to illustrate possible immediate loss due to current erosion (NAIL), the net present value of future losses due to current erosion (NDIL) and the net present value of cumulative future erosion (NDCIL). Their relationships to macroeconomic indicators of the strength of the economy are also discussed.

Parameters for the policy analysis must be set by the political authorities in Lesotho, after more profound research into the underlying agronomic relationships. The text here on this point serves only to illustrate the implications of a set of debatable but explicit and not unreasonable assumptions.

It is shown that, given certain illustrative values of erosion impact, discount rate and time horizon, erosion on crop land entails significant losses to the Lesotho economy. The irreversible character of this process, coupled with its propensity to strike the poorest segment of the economy adds weight to the call for political attention to the problem of land degradation.

Building on the analytical framework established in chapter 2, section 3.3 of this chapter considers market and government failures as they relate to land degradation in Lesotho.

Externalities on grazing land is a key environmental problem in Lesotho. On crop land, on-field impacts have good prospects of becoming internalized, given sufficient information on erosion-yield relationships. However, off-field impacts and crop residue grazing cause negative externalities. Some conservation structures have a public good nature and cannot be efficiently supplied by private

initiative. There is a potential role for communal land management, backed by national legislation, training and research.

The average farmer in Lesotho has limited access to formal future and risk markets. However, real rates of interest for agricultural credit are low, and this study casts some doubt on credit supply being an important constraint for investments in land improvements. There are substantial migrant remittances as a source of capital, and the Lesotho economy is found to be monetarized to a considerable extent: more than half of the rural households state migrant remittances as their main source of income. High risk is probably a major deterrent to improved crop management, but insurance markets are not developed in Lesotho. Some risk is absorbed by credit institutions which rarely proceed to take legal action in cases of default.

Turning to government policies, past land improvement efforts have been poorly documented. To the extent that evaluation is possible to undertake, the soil conservation projects have largely been unsuccessful. Recent conservation efforts are better integrated in agricultural development schemes, but the major government programme in this field, the Food Self-Sufficiency Programme, lacks a soil conservation component.

The legislation pertaining to conservation of land is rigorous, but generally not implemented. It often lacks subordinate regulations and provisions for effective enforcement. Property rights to crop land provide for inheritance and secure usufruct rights. However, there is no legal market for the sale of rural land. Leasing arrangements that could ensure more efficient management of crop land are hampered by the lack of a legal framework.

The lack of enforced communal property rights on range land makes the regime approach one of "open-access", and encourages overstocking by privately rational farmers. Ongoing work to re-adjudicate cattlepost grazing rights is a step in the right direction, but will still take many years still to complete. The establishment of Range Management Areas is being promoted, but experience has

shown them to be crucially dependent on external, donor-funded support. There are currently attempts of introduction a national grazing fee for livestock. The obstacles for actual implementation are severe.

Lesotho lacks a population policy, and there is little political concern voiced over the population growth of 2.6 percent per annum. The rural "surplus" population forms a growing stratum of landless without livestock. In an economy with poor absorption capacity in the formal sector, limited prospects for increases in emigration, an overgrazed range land and no extra crop land to allocate, the growing number of rural poor will aggravate environmental pressure from a group that cannot afford to consider long-term sustainability. It should be recalled, however, that the recent political changes in the RSA may radically change the prospects for migration.

Domestic price regulation is very limited in Lesotho. There is some price raising impact on agricultural output from price support in the RSA which encourages cultivation, leading to aggravated land degradation. Trade policy is intimately linked to SACU membership, and entails import barriers to foreign agricultural produce. Income taxes and indirect taxes play a limited role in the Lesotho economy, and public revenue is primarily based on customs income. On all these counts, there are virtually no degrees of freedom to pursue a domestic policy, given the dependence on South Africa.

The current political élites and the bureaucracy base their power on military rule, traditional chieftainships and the underlying consent of the powerful neighbour. Measures to alter the property rights of rangeland are difficult to implement, due to the perceived interests of those sections of the élite with considerable livestock ownership. Reforms to create a commercial market for land conflicts with the interests of the chiefs and their traditional privilege to allocate crop land. The generally low efficiency of the administration hampers the implementation of land improvement programmes.

The review of public spending shows that the share of agricultural spending in Lesotho is in line with the average for sub-Saharan Africa, i.e. less than its share of the domestic economy. The largest agricultural

programme is aimed to modernize crop production, but does so in a manner demanding substantial subsidies. The major public investment programme - the Lesotho Highlands Water Scheme - has had an ambitious start in making its Environmental Impact Assessment, and designing plans for the improvement of land affected by the project. If these are implemented as intended, the net impact will be a considerable improvement for the lands and population affected. However, there is no prospect for rural electrification, potentially reducing environmental pressure from fuelwood and dung gathering.

Public environmental information and debate is circumscribed by the government's dominance over domestic media and the ban on party politics. The latter may change soon, as it has been announced that elections will take place in 1992. A small but independent press exists in Lesotho, and land degradation is openly debated, although some of its facets may be delicate. The National Environmental Action Plan, adopted in 1989, is one example of the willingness to openly discuss land utilization issues.

REFERENCES

Board of Trade and Industry, Pretoria, 1990: Letter to the present author, dated August 23, 1990.

Bojö, J., Mashinini, V., Mokhothu, M. and Rydgren, B., 1988: Interdisciplinary Analysis of Soil and Water Conservation Projects. A report to SAREC. Stockholm School of Economics. Stockholm.

Bojö, J., (forthcoming): Marketable Grazing Permits - the Solution to Overstocking of Rangelands? Research Paper. Stockholm School of Economics. Stockholm.

BoS (Bureau of Statistics), 1986: Lesotho Agricultural Situation Report. Maseru, Lesotho.

Bos, 1987: Statistical Yearbook 1987. Maseru, Lesotho.

BoS, 1988: Incomes, Expenditure and Consumption of Basotho Households. Main Results from the Household Budget Survey 1986/87. Maseru, Lesotho.

BoS, 1989: Basotho Women and their Men. Females and Males in Lesotho. Statistics divided by Gender. Maseru, Lesotho.

BoS, 1990a: The Labour Force of Lesotho. A Statistical Report Based on the Labour Force Survey 1985/86. Round 1. Maseru, Lesotho.

BoS, 1990b: National Accounts Tables. Update, November 1990. Maseru, Lesotho. Mimeo.

BoS, 1990c: Statistical Yearbook 1988. Maseru, Lesotho.

Breytenbach, W.J., 1975: Crocodiles and Commoners in Lesotho. Continuity and Change in the Rulemaking System of Lesotho. Communications of the Africa Institute. No. 24. Pretoria.

Central Bank, 1983: Quarterly Review. March. Maseru, Lesotho.

Central Bank, 1986: Quarterly Review. September. Maseru, Lesotho.

Central Bank of Lesotho, 1990a: Annual Report 1989. Maseru, Lesotho.

Central Bank of Lesotho, 1990b: Quarterly Review. Vol. 11. No. 2. June. Maseru, Lesotho.

CFI (Commissioner of Financial Institutions), 1979: Report by the Commissioner of Financial Institutions for the Period 1st January until 31st December 1978. Maseru, Lesotho.

Chakela, Q. and Cantor, J., 1986: History of Soil Conservation and Soil Conservation Policy in Lesotho. A report to the SADCC Coordination Unit. Maseru, Lesotho.

Chakela, Q., Molapo, J. and Putsoane, T.G, 1989: Erosion Hazard Mapping of the SADCC Region. Part 3. Lesotho. SADCC Soil and Water Conservation and Land Utilization Sector Coordination Unit. Maseru, Lesotho.

Cooper, D., 1988: Working the Land. A Review of Agriculture in South Africa. Eda. Johannesburg.

CPDO (Central Planning and Development Office), 1989: The Formulation of a Documented Population Policy for Lesotho: Workshop Proceedings. Parts I - III. Maseru, Lesotho.

Crosson, P.R. with Stout, A.T., 1983: Productivity Effects of Cropland Erosion in the United States. RFF. Washington, D.C.

Eckert, J., 1980: Quantitative Analysis of Lesotho's Official Yield Data for Maize and Sorghum. Research Report No. 8. Lesotho Agricultural Sector Analysis Project. Ministry of Agriculture, Maseru, Lesotho, and Department of Economics, Colorado State University, USA.

Eckert, J., 1982: Rainfall Oscillations in Lesotho and the Possible Impact of Lower Precipitation in the 1980s. Department of Economics, Colorado State University, USA. Mimeo.

EIU, 1990a: Namibia, Botswana, Lesotho, Swaziland. Country Report. Quarterly Reports. The Economist Intelligence Unit. London.

EIU, 1990b: Namibia, Botswana, Lesotho, Swaziland. Country Profile 1990-91. The Economist Intelligence Unit. London.

EIU, 1991: Namibia, Botswana, Lesotho, Swaziland. Country Report. Quarterly Report 1. The Economist Intelligence Unit. London.

Eklöf, J. and Molapo, P., 1989: Distribution of Incomes and Consumption in Lesotho. A Study Based on the 1986/87 Household Budget Survey. Staff Occasional Paper No. 4. Central Bank of Lesotho. Maseru, Lesotho.

FAO, 1987: Report of the Investment Support Programme. Investment Centre. Food Self-Sufficiency Credit Project, Preparation Mission. Rome.

FAO, 1989: Lesotho. Agricultural Marketing and Credit Project. Project Completion Report. FAO/World Bank Cooperative Programme. Investment Centre. Rome.

Ferguson, J., 1990: The Anti-Politics Machine. "Development" Depoliticization and Bureaucratic Power in Lesotho. Cambridge University Press. Cambridge.

Gay, J., 1984: "Basotho Attitudes to Erosion and Conservation", in Schmitz, G. (ed.), Lesotho - Environment and Management. Vol. I. National University of Lesotho. Roma, Lesotho.

Grainger, A., 1990: The Threatening Desert. Controlling Desertification. Earthscan. London.

Green, T.J., 1990: National Survey of Biomass/Woodfuel Activities in Lesotho. SADCC Energy Sector Technical and Administrative Unit. Luanda, Angola.

Hahn, T., 1990: A Financial Analysis of Fodder Production and Feeding of Sheep and Goats. A Case Study from Mohale's Hoek District, Lesotho. Swedish University of Agricultural Sciences International Rural Development Centre. Working Paper 142. Uppsala, Sweden.

Hesling, L., 1984: Rainfall, Fertiliser Application and Crop Yield in Lesotho. Ministry of Agriculture, Planning Division. Maseru, Lesotho. Mimeo.

Holland, D. & Ts'iu, M., 1983: 1982/83 Crop Enterprise Budgets: Traditional and Improved Production Practices. Research Division, Ministry of Agriculture. Maseru, Lesotho.

Hurni H., 1985: Erosion - Productivity - Conservation Systems in Ethiopia. Paper presented for the IV International Conference on Soil Conservation, November 3-9, 1985, Maracay, Venezuela. University of Bern, Switzerland.

Hutton, D. (ed.), 1989: Business Blue-Book of South Africa. 1989. National Publishing (Pty) Ltd. Cape Town, RSA.

IFAD, 1986: Appraisal Report, Lesotho Local Initiatives Support Project. Report No. 0026-LE. International Fund for Agricultural Development. Rome.

IMF, 1989: Lesotho - Recent Economic Developments. Washington, D.C. Mimeo.

Johnston, J., 1984: Econometric Methods. Third Edition. McGraw-Hill. Singapore.

Kaphwioy, K.M. 1990: Women in Development. Women and Credit. Paper to the UNDP Seminar 19 October 1990, Maseru, Lesotho. Mimeo.

Kmenta, J., 1986: Elements of Econometrics. Second Edition. Macmillan. New York.

Lal, R., 1981: "Soil Erosion Problems on Alfisols in Western Nigeria, VI. Effects of Erosion on Experimental Plots.", pp. 215-230 in Geoderma. Vol 25.

The Land Act of 1979. Maseru. Lesotho.

Lawry, S.W., 1987a: Communal Grazing and Range Management: The Case of Grazing Associations in Lesotho. African Livestock Policy Analysis Network. Network Paper No. 13. ILCA. Addis Ababa, Ethiopia.

Lawry, S.W., 1987b: Report of the Consultancy on Grazing Management and Administration. Prepared for the Land Conservation and Range Development Project, USAID. Range Management Division, Ministry of Agriculture, Government of Lesotho. Mimeo.

The Laws of Lerotholi (n.d.). Maseru, Lesotho.

LCC (Lesotho Cooperative College), 1986: Lesotho Cooperative Development Support Programme. Summary of Management Survey Report. Ministry of Agriculture Cooperatives and Marketing. Maseru, Lesotho.

LCC, 1987: Statistics. Cooperative Societies in Lesotho. Maseru, Lesotho.

LEMP, 1988: Lesotho Energy Master Plan. Summary Report. Ministry of Water, Energy and Mining, Department of Energy and GTZ. Maseru.

Lesotho Government Gazette, Vol. 35. No. 59.

LHDA (Lesotho Highlands Development Authority) 1990a, LHWP Rural Development Plan. Phase 1A. Volume 1. Summary. Maseru, Lesotho.

LHDA, 1990b: LHWP Rural Development Plan. Phase 1A. Volume 2. Animal Husbandry and Range Management. Maseru, Lesotho.

LHDA, 1990c: LHWP Rural Development Plan. Phase 1A. Volume 3. Mountain Horticulture and Field Crops. Maseru, Lesotho.

LHDA 1990d, LHWP Rural Development Plan. Phase 1A. Volume 4. Community Forestry. Maseru, Lesotho.

LHDA 1990e: LHWP Rural Development Plan. Phase 1A. Volume 8. Village Infrastructure. Maseru, Lesotho.

Lindberg, O., 1987: Report on Coop Lesotho and Cooperative Development from a Supervision Mission to Lesotho 21st October to 3rd November, 1987. Lesotho Agricultural Marketing and Credit Project. Mimeo.

LNLTF (Lesotho National Livestock Task Force), 1990: National Livestock Policy Implementation Plan. Maseru, Lesotho. Mimeo.

LPIC (Livestock Policy Implementation Committee), 1991: Grazing Fee Implementation Plan for Lesotho. Ministry of Agriculture, Cooperatives and Marketing and Ministry of Interior, Chieftainship and Rural Development. Maseru, Lesotho. Mimeo.

Lundahl, M., Fredriksson, P and Moritz, L., 1990: South Africa 1990: Pressure for Change. Department of International Economics and Geography. Stockholm School of Economics. Stockholm, Sweden. Mimeo.

Lundahl, M. and Petersson, L., (forthcoming): The Dependent Economy: Lesotho and the Southern African Customs Union. Westview Press. Boulder.

Mashinini, V., 1988: Soil and Water Conservation in Maphutseng, Mohale's Hoek, Lesotho. National University of Lesotho. Dept. of Geography. Roma, Lesotho.

Mashinini, V., 1989: Land Tenure, Land-Use and Conservation in Maphutseng, Mohale's Hoek, Lesotho. National University of Lesotho. Dept. of Geography. Roma, Lesotho.

McAuslan, P., 1987: "Lesotho Highlands Water Project and Environmental Law" pp. 41-65 in Lesotho Law Journal. Vol. 3. No. 2.

McAuslan, P. and Michanek, G., 1988: Soil and Water Conservation Law in Lesotho. SADCC Soil and Water Conservation and Land Utilization Programme. Mimeo.

Meissner, H.H., 1989: Report on Carrying Capacity and Animal Unit Equivalent in Lesotho. Department of Livestock Science, University of Pretoria. Pretoria. Mimeo.

MoA (Ministry of Agriculture, Cooperatives and Marketing), 1972?: The Conservation of Soil, Water and Renewable Natural Resources in Lesotho. A Statement of Policy. Maseru, Lesotho. Mimeo.

MoA, 1979: Phuthatsana Irrigation Project, Reformulation Report. Maseru, Lesotho. Mimeo.

MoA, 1987: Government of Lesotho Statement on Agricultural Policy Issues - Crop Production of 18 August, 1987. Maseru, Lesotho. Mimeo.

MoA, 1988a: Lesotho National Rangeland Inventory: Methodology, Results and History from 1981 through 1988. Range Management Division. Land Conservation and Range Development Project. Maseru, Lesotho. Mimeo.

MoA, 1988b: Natural Resource Inventory. Conservation Division. Maseru, Lesotho. Mimeo.

MoA, 1989: Press Release, 12 October, 1989.

MOHSW (Ministry of Health & Social Welfare, 1979: Report of National Conference on Population Management as a Factor in Development, Including Family Planning. Maseru, Lesotho.

MoP (Ministry of Planning, Economic and Manpower Development), 1987: Fourth Five-Year Development Plan (1985/86-1990/91 Fiscal Years). Vol. 1. Maseru, Lesotho.

Mpona, T.M. and Traerup, E., 1986: Report on Survey of Education Needs and Review of Existing Material. Lesotho Cooperative Development Support Programme. MoA. Maseru, Lesotho.

Murray, C., 1981: Families Divided. The Impact of Migrant Labour in Lesotho. Ravan. Johannesburg.

NEAP (National Environmental Action Plan), 1989: Kingdom of Lesotho. Maseru, Lesotho.

Nobe, K.C., and Seckler, D. W., 1979: An Economic and Policy Analysis of Soil-Water Problems in the Kingdom of Lesotho. LASA Report no. 3. Ministry of Agriculture and Dept. of Economics, Colorado State University.

Olsson, U., 1988: Agricultural Statistics in Lesotho. Report from a Short-Term Mission February 29 - March 18, 1988. SCB Statistics Sweden. Lesstat 1988:4. Stockholm.

Petersson, L., 1989: Lesotho: Makroekonomisk utveckling och ekonomisk politik. Nationalekonomiska institutionen. Lund, Sweden.

Petersson, L., 1990: Lesotho. Macroeconomic Studies. The Planning Secretariat, SIDA and the Institute for Economic Research, University of Lund. Stockholm, Sweden.

Pim, A.W. 1935: Financial and Economic Position of Basutoland. Report of the Commission Appointed by the Secretary of State for Dominion Affairs. His Majesty's Stationery Office. London.

Plath, J. 1982: 1980/81 Crop Enterprise Budgets: Traditional Production Practices. Research Division, Ministry of Agriculture. Maseru, Lesotho.

Range Management and Grazing Control Regulations. 1980. Maseru, Lesotho.

Repetto, R., Magrath, W., Wells, M., Beer, C. and Rossini, F., 1989: Wasting Assets. Natural Resources in the National Income Accounts. World Resources Institute. Washington, D.C.

RSA (Republic of South Africa) Government Gazette, 1969: Custom Union Agreement between the Governments of the RSA, the Republic of Botswana, the Kingdom of Swaziland and the Kingdom of Lesotho. Vol. 54. No. 2584. Pretoria, RSA.

Schmitz, G. (ed.), 1984: Lesotho. Environment and Management. National University of Lesotho. Roma, Lesotho.

Schmitz, G. and Rooyani, F., 1987: Lesotho. Geology, Geomorphology, Soils. National University of Lesotho. Roma, Lesotho.

Stocking, M., 1985: Erosion-Induced Loss in Soil Productivity. A Research Design. FAO. Rome.

Swallow, B.M., Mokitimi, N., Brokken, R.F., 1986: Cattle Marketing in Lesotho. Research Division, Ministry of Agriculture. Maseru, Lesotho.

Swallow, B.M., Brokken, R.F., Motsamai, M., Sopeng, L. and Storey, G., 1987: Livestock Development and Range Utilization in Lesotho. Research Division, Ministry of Agriculture. Maseru, Lesotho.

Temple, P.H., 1972: "Measurements of Runoff and Soil Erosion at an Erosion Plot Scale with Particular Reference to Tanzania", pp. 203-220 in Geografiska Annaler. Vol. 54 A. No. 3-4.

UNDP and World Bank, 1989: African Economic and Financial Data. New York and Washington, D.C.

Vittal, K.P.R, Vijayalakshmi, K. and Rao, U.M.B., 1990: "The Effect of Cumulative Erosion and Rainfall on Sorghum, Pearl Millet and Castor Bean Yields under Dry Farming Conditions in Andhra Pradesh, India", pp. 429 - 439 in Experimental Agriculture. Vol. 26.

Wellings, P.A., 1986: "Modern-Sector Development and South African Investment: A Viable Strategy for Lesotho?", pp. 4-15 in Journal of African Studies. Vol. 13. No. 1.

Wilken, G., 1982: Agroclimatic Hazard Perception, Prediction, and Risk-Avoidance Strategies in Lesotho. Dept. of Geography, Colorado State University. Working Paper no. 44.

World Bank, 1986: Lesotho Agricultural Sector Review. Report No. 5866-LSO. Washington, D.C.

World Bank, 1987a: Lesotho Country Economic Memorandum. Report NO. 6671-LSO. Washington, D.C.

World Bank, 1987b: Project Completion Report. Lesotho Basic Agricultural Services Program Project. Washington, D.C.

World Bank, 1990a: Lesotho: Policy Framework Paper, 1990/91 to 1992/93. Washington, D.C.

World Bank 1990b: World Development Report 1990. Oxford University Press. Oxford.

REFERENCE PERSONS[1]

Bazil, John E., Forest Research Officer, Forestry Division. Ministry of Agriculture, Cooperatives and Marketing.

Boykin, Calvin, Livestock Economist, Lesotho Agricultural Policy Support Programme (LAPSP), Ministry of Agriculture, Cooperatives and Marketing.

Buhl-Nielsen, J, Cooperative Adviser, Cooperative Development Centre.

Guindon-Zador, Evelyn, Coordinator, Family Health Initiatives II Project, USAID.

Hognert, Lennart, Planning Adviser, Ministry of Agriculture, Cooperatives and Marketing.

Jenness, Jonathan, Senior Rural Development Adviser, LHDA Environment.

Karlsson, Erik, Governor, Central Bank of Lesotho.

Mabusane, FSSP Records Officer, Ministry of Agriculture, Cooperatives and Marketing.

Mashapha, Manager, Lesotho Agricultural Development Bank, Mohale's Hoek.

Mohapi, Nthunya, Joe, Head of Agricultural Statistics Division, Bureau of Statistics.

Mokotjo, J.L, Chief Marketing Officer, Ministry of Agriculture, Cooperatives and Marketing.

Nkalai, David, Conservation Adviser, LHDA.

Rydgren, Bernt, Land Use Adviser, Division of Land Use Planning, Ministry of Agriculture, Cooperatives and Marketing.

Sarhan, Mike, E., Agricultural Economist, Lesotho Agricultural Policy Support Programme (LAPSP), Ministry of Agriculture, Cooperatives and Marketing.

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4. COST-BENEFIT ANALYSIS OF LAND IMPROVEMENT PROJECTS: THEORY AND APPLICATIONS

4.1 Introduction

The two previous chapters have dealt with the macroeconomic perspective on land degradation and rehabilitation. Analysis on that level can help to explain why land degradation occurs and to identify crucial areas for policy reform in order to reduce divergencies between private and social costs and benefits of land management. Removal of detrimental policies is one part, institutionalization of new ones is another. Sound land management requires that property rights are well-defined and enforced. Public intervention on that account appears preferable to individual "strong arm" enforcement.

Quantitative macroeconomic analysis can also tell us something about the magnitude of land degradation impact, in order to correctly inform individuals making land use decisions. Information about land degradation and rehabilitation has a public good nature. Once the information is produced, the problem of selling exclusive access to it appears. Private companies cannot be totally relied upon to do research on land rehabilitation and spread its results via a commercial extension service to farmers.

Much can be accomplished by removing policies inducing land degradation and instituting others that have a positive impact. The question arises of whether there is a residual role for more **selective** interventions in the form of special programmes or projects aimed at combating

land degradation? If there is such a role, project level analysis is important to enhance efficient resource use.

Provision of incentives and management capacity for land rehabilitation is often done through area-based efforts during specific time periods: "projects". Increasing disenchantment with this approach has stimulated the development of "programmes" with less definite time restrictions and sometimes encompassing the entire nation. In reality, the line of demarcation between these concepts is floating. Both projects and programmes engage scarce resources of qualified personnel and material inputs, which provides an opportunity for economics to fulfil its classical role. From this perspective, there is no difference between a project and a programme, and both will be subsumed under the "project" label here.

When combating land degradation, specific projects rather than general policy reform is the traditional mode of operation. There are at least two reasons for this. Firstly, the issue of policy reform in Third World countries is a delicate matter, which some donors desire under tactful silence. Domestic groups demanding policy changes may be repressed or politically weak, since land degradation often hurts disadvantaged groups of society. The IMF and the World Bank have assumed a leadership role in insisting on policy reforms. Often, this is now supported by bilateral donors.[1] Still, the emphasis in land improvement activities lies very much on specific projects, which can by-pass difficult macro economic issues and, to some extent, the hurdles of bureaucracy, and deal directly with local problems. Secondly, the project mode of operation is well suited to the way in which aid institutions function, dependent as they are on time limited appropriations and a need to demonstrate short-run impacts.

This opens up "an easy way out": regardless of any academic discourse, governments and donor agencies behave **as if** selective projects are appropriate means of enhancing land management. As long as this situation remains, there is a legitimate field open to the project analyst. However, this "pragmatic" argument is not entirely satisfactory, as it leaves unanswered the more profound question of whether the best line of action is

1. Lesotho is a case in point, see chapter 3.

being pursued. The history of conservation provides ample evidence of the costly failures of the selective intervention approach. Certainly, projects will fail if put against a general environment full of disincentives, which is one reason why macroeconomic analysis is so important to undertake.

Realistically, some externalities are likely to remain even after general policies have been improved. In relation to crop land, there will be off-site impacts of land degradation and it is difficult to fully define and enforce the rights and obligations of each land user in this respect. Furthermore, the communal range management systems in many developing countries are not likely to be transformed to private ranches, but retained as common property with imperfect internalization of household livestock management actions.

However, remaining externalities are not a sufficient reason per se for selective public intervention. Following the influential work of Coase (1960), the burden of proof has shifted to government in order to show that its intervention, all costs accounted for, is actually better than the outcome realized by markets. Remaining externalities may be "Pareto-irrelevant" (Buchanan and Stubblebine, 1962; Randall, 1983): externalities that are too costly to correct are best left alone. Thus, if land degradation continues to occur, it may be a sign that the costs of preventing it may simply be too high. A specific cost-benefit analysis is needed to determine whether or not this is the case.

Changing the management system of the range or crop land is a complex undertaking, requiring the people's own participation, but often also some external impetus to encourage change. Thus, selective projects can serve as important complements to general policy reform, in the legitimate public role of providing public goods and reallocating resources. There are some essential features of the inputs provided by selective projects.

(1) A targeted doses of relevant **information.** Training college students the general techniques of soil conservation may be useful, but even more so is probably the training of local farmers in dealing with the actual land management problems in their own area. Thus,

information can be tailored to the specific needs of a project area.

(2) A project can provide important **short-term visible benefits** such as cash for work, agricultural inputs timely delivered at accessible points, transportation to markets and so on. Such provisions are costly and cannot be administered to an entire nation at once, but may have important demonstration impacts initiating a chain of spontaneous diffusion.

(3) A new management **authority** that provides **assurance** for new rules of behaviour: professional competence, backed by (some degree of) legitimacy of established governmental authority, and a check on local vested interests and petty corruption which may undermine local initiatives for development. This may brake the deadlock in a Pareto-inferior equilibrium of open-access to range land or short-term share-cropping with ensuing "soil mining" behaviour.

(4) A chance to **generate new information** from limited, and therefore less costly and risky set of actions, and thereby to gradually improve the more general policy. If the introduction of a fodder grass or the establishment of a local range management authority turn out to be successful, the experience gathered can guide broader actions on these matters.

In summary, the selective approach can target the use of information, material resources, managerial authority and feed-back in a way that adapts to local conditions. This provides some rationale for differentiated, selective interventions. Together with the more pragmatic argument made above, this gives a basis for the continued need for project level economic analysis pertaining to land degradation.

In the neo-classical tradition, the major analytical tool in this study is cost-benefit analysis (CBA). Some authors prefer to speak about "social cost-benefit analysis" to differentiate this from "traditional" or "economic" cost-benefit analysis, where allowance is not explicitly made for income distribution concerns. As will be explained later, these concerns are regarded here as

inherent in CBA, and the prefix "social" appears redundant.[2]

The **purpose** of this chapter is to systematically review the **theory** of CBA and how it has been **applied** in empirical analyses of soil and water conservation projects. Thereby, this chapter provides a background for the CBA study from Lesotho, presented in chapter 5. We want to learn both from the theoretical contributions and from the applied studies, in order to effectively undertake our own analysis. The purpose is not to derive new theory pertaining to cost-benefit analysis, but to contribute to one of the overriding purposes of this dissertation: the efficient design of remedies for land degradation. While there are many reviews of cost-benefit theory in general, the format here is intended to bring out the dual picture of theory and application in a particular field that has been the subject of very limited attention among professional economists. We are not aware of any similar review in this particular field.

The rest of this chapter is organized as follows. Section 4.2 offers a working definition of cost-benefit analysis and surveys nine analytical steps in applied CBA. For each step, in sections 4.3 - 4.11, there is a discussion as to how empirical analyses of soil conservation projects have been able to adequately consider theoretical guidelines. Section 4.12 summarizes the chapter.

2. See e.g. Helmers (1979) and Irvin (1978) for a discussion.

4.2 An Introduction to Cost-Benefit Analysis[3]

Cost-benefit analysis has its roots in the normative branch of neoclassical economics, sometimes referred to as welfare economics. The approach is individualistic, and it is assumed that:

(1) Individuals are the best judges of their own welfare;

(2) The welfare of society is an aggregation of individual welfare;

(3) If the welfare of somebody increases, and no one else is worse off, the social welfare has increased.

These value judgements are the basis of Paretian welfare economics (Mäler, 1985). However, they do not take us very far in determining the relative value of various actions, as generally somebody is worse off by any activity. This has led to the development of tests for potential Pareto improvements, all of which are problematic. There have also been attempts to develop a social welfare function on the basis of ordinal utilities (Bergson-Samuelson welfare orderings). However, these efforts were effectively discouraged by Arrow's Impossibility Theorem. The Theorem shows that there is no non-dictatorial way to aggregate individual preferences without violating a set of reasonable conditions. (Helmers, 1979).

It appears that a welfare ordering has to be postulated, representing the relevant decision-maker (Mäler, 1985). In our context, this could be the government of the country where activities to counter land degradation takes place, or the donor agency supplying resources for this project. This suggests a **definition of cost-benefit analysis** as:

> A method to identify and quantify social advantages (benefits) and disadvantages (costs) in terms of a common monetary unit. Benefits and costs are valued on the basis of individual welfare changes, as viewed

3. The theoretical foundation of CBA is discussed in Drèze and Stern (1987) and Mäler (1985). Less technical discussions are contained in Cooper (1981) and Smith (1986).

through a social welfare ordering representing the preferences of the relevant decision-maker. The individual welfare changes can be expressed as compensating variation (CV) or equivalent variation (EV).[4] Under certain conditions, and for goods and services bought on markets, they can be approximated with the consumer surplus (CS) as revealed by a Marshallian demand curve.[5] Welfare changes are commonly captured by measuring the willingness to pay (WTP)[6] among consumers. The flow of monetary units over time is brought together to a net present value. Unvalued effects (intangibles) are described qualitatively and put against quantified values.

CBA is a normative exercise aimed at providing policy relevant conclusions, aiding, but not dictating, decision-making. As CBA ultimately rests on ethical values, the idea that its results are somehow "objective" is not advocated here. CBA is controversial, but this is not the proper place to discuss the criticism against CBA, which is more frequent among non-economists than within the discipline.[7] The approach taken here is to concentrate on the application of CBA in the particular context of land degradation and rehabilitation.

The emphasis on market-orientation versus planning orientation varies in CBA. The perspective of an impersonal "planner" is probably the dominant one, (Dasgupta et al, 1972; Little and Mirrlees, 1974; Drèze and Stern, 1987). The more market-oriented approach is found in Mishan (1982). The latter wants to minimize the role of politically determined parameters. The view taken here is one of CBA as a tool for planning of projects from the point of view of LDC governments and donor agencies. This is not to neglect the need to base such

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4. CV is the monetary transfer necessary to keep an individual at the **ex-ante** welfare level, following a change in the set of prices. EV is the monetary transfer which equals the change to the **ex-post** welfare level due to a change in the set of prices. Both are valid measures, but take different perspectives on the change.
5. See Willig (1976) and Mitchell and Carson (1989).
6. In principle, willingness to accept compensation (WTA) could also be used to express welfare changes. However, this measure has generally performed less well in empirical situations (Mitchell and Carson, 1989).
7. The author's views on this point are summarized in Bojö et al (1990, pp. 83-85).

planning on individuals' WTP whenever this can be recorded, nor to neglect the role of popular participation in the design, implementation and evaluation of development projects. Furthermore, the CBA should include a **financial** analysis considering the individual or household perspective. This can give important insights into the actual incentives on the market and bring out interesting contrasts between the financial and the economic perspectives.

There are several possible time perspectives for a CBA in relation to a project. The general cases could be classified in three groups:

(1) Looking at a planned project (or projects) in advance (ex-ante appraisal);

(2) Looking at an operational but not completed project (on-going evaluation);

(3) Looking at a completed project (ex-post evaluation).

It should be noted that the "completion" of a project usually refers to the time of withdrawal of external support, rather than the vanishing of any significant impacts of the project. Thus, even an ex-post evaluation commonly involves some degree of future projections.

In order to consider the impacts of a project, CBAs ideally contain a sequence of analytical steps such as the following:

1. The establishment of **evaluation criteria**. While the maximization of social welfare remains the general goal, data on individual welfare changes (CV or EV) cannot in general be obtained for all individuals concerned. Therefore, the maximization of income will serve as a proxy, although, as generally agreed, an imperfect one. The basic concept here is the Net Present Value (NPV). This is commonly defined as:

$$NPV = \sum_{t=0}^{T} (B_t - C_t)/(1 + r)^t$$

where

t = time index
T = final period considered
B = social benefits
C = social costs
r = social rate of discount

The social costs and benefits in this formula represent the weighted sums of individual WTP. As discussed more below, there are other measures of project worth, and there are also variables not expressed in the numeraire of the analysis - intangibles - to consider.

2. Determining **distributional considerations** is a part - implicitly or explicitly - in the use of evaluation criteria, since the NPV contains a weighted sum of individual costs and benefits. The fact that all monetary units are usually weighed equally, regardless to whom they accrue, does not relieve us from the responsibility of considering this aspect. This appears particularly relevant in a developing country context and will be discussed further below.

3. **Identification** of relevant inputs and outputs of the project is the next step. This entails the delineation of the geographically and economically relevant area, and by implication, what individuals to consider. The standard assumption is that all n:s living in the nation where the project takes place should be included, whereas others are excluded. In principle then, N should change with t as a part of the usual demographic processes.

Conceptually, the with-and-without (project) approach should be used. This is to include in the analysis only such factors that actually change because of the project. Irrelevant variables, such as "sunk costs", should be sorted out. Exogenous, non-project, changes such as climatic influences, must also be separated from changes actually due to the project.

4. **Quantification** of inputs and outputs is the next step. In the context of analyzing land degradation this presents problems since our knowledge of the underlying ecological relationships is quite incomplete. As has been pointed out in chapter 2, little is known about the

quantitative effect of land degradation on crop and grass yield. Decisions still have to be made, and CBA can be a useful aid in organizing available information. Sensitivity analysis can test the extent to which uncertainties actually matter for decision-making purposes.

5. **Valuation** of costs and benefits comes next. This entails applying "social price tags" on the effects previously quantified. Sometimes the adjustments for transfer payments, incorporation of externalities and shadow pricing of labour and foreign exchange may make quite a difference when contrasting the financial and the economic perspective.

6. **Discounting** using a real social rate of discount is a controversial subject and is discussed in detail in section 4.8. From a theoretical point of view, r should be indexed, as it may change over the time horizon considered.

7. Discounting should be done over the appropriate **time horizon**. In principle, an infinite length of time could be considered. In practice, CBAs often limit the horizon, because effects of a project tend to decline after some time. The choice of time horizon is also related to the choice of discount rate. The higher the discount rate, the lower the weight attached to long-term effects.

8. Considering **uncertainties** and **risks** is problematic for all kinds of evaluation, economic and non-economic, CBA or non-CBA. While CBA holds no magic solution to this problem, it contains a systematic method of testing what importance uncertainty has for the value of evaluation criteria. The issue is dealt with in section 4.9.

9. **Policy conclusions** should be drawn in terms of the set of planning goals that the decision-maker (LDC government, aid agency etc.) have defined. Value judgments will always be involved in the execution and interpretation of CBA. Efficiency considerations have to be weighed against other social values. This does not diminish the value of having certain part of the "political map" quantified. Gains in relation to other goals can then be explicitly traded off against losses of net present value.

As we shall see, empirical application of these theoretical steps entails very considerable simplifications. The 20 empirical studies reviewed are listed below.

Table 4.1 Reviewed CB-studies

Author(s)	Year published	Location
1. Abelson	1979	Australia
2. Anderson	1987	Nigeria
3. Bali	1977	India
4. Brooks et al	1982	Morocco
5. Christophersen & Karch	1988	Mali
6. Das & Singh	1980	India
7. Figueroa & Garduno	1980	Mexico
8. Gauchon & Lok	1973	South Korea
9. Gauchon	1976	Indonesia
10. Gupta et al	1973	India
11. Harris	1982	New Zealand
12. Hedfors	1981	Kenya
13. Holmberg	1985	Kenya
14. Kislova	1979	USSR
15. Lockeretz	1981	USA
16. Mwakalagho	1983	Malawi
17. Narayanan et al	1974	USA
18. Nobe & Seckler	1979	India
19. Veloz et al	1985	Dominican R.
20. Wiggins	1980	El Salvador

The numbers (1-20) used in table 4.1 will sometimes designate the source in this chapter. The criteria for selection of studies have been (1) that the study concerns a project with an explicit component of land improvement, and (2) that a cost-benefit perspective is applied in the economic calculations. Obviously, more CB-studies of soil and water conservation projects exist. The ambition is not to provide a complete coverage, but a coverage wide enough for some well-founded observations to support the work reported on in chapter 5. The principles of declining marginal benefit and increasing marginal costs also apply to the collection of empirical

CBAs of land improvement projects. These considerations have limited the number to 20.

The selected studies vary considerably in length and analytical depth. They cover a wide range of soil and water conservation measures, and no attempt is made to present each project under study here. As our focus is on methods used in the analysis, the details of the projects are of minor importance. However, a few lines serve to convey a general sense of the projects reviewed.

Several of the projects cover quite large areas of tens of thousands of hectares and up to as much as one million inhabitants affected (20) by project activities. Some have an integrated watershed management character (1, 4, 8, 9, 16, 17, 19, 20). At the other end of the scale, there are small scale and specialized studies of water conservation structures (6), terraces (7), and crop plots subject to artificial desurfacing (18). Most studies analyze primarily cereal crops, some grassland production and impacts on livestock (1,11), and some focus on fuelwood production (especially 2) as related to conservation goals, or the use of crop residues for soil conservation versus energy purposes (15). Most studies take an ex-post or on-going evaluation perspective, but some explore the potential of future investments. What binds all studies together is the common concern to systematically weigh costs and benefits in terms of a common monetary denominator.

4.3 Planning Perspectives and Evaluation Criteria

It is unlikely that formal CBAs will determine the social allocation between and within such sectors as defense, health and education. Such allocations are determined in a political web of considerations, only partially amenable to economic analysis.[1] However, when it comes to the setting of priorities for development among - and particularly **within** - sectors such as industry, infrastructure and agriculture, CBA has a role to play. One may want to consider alternative options for a project regarding location, size, specific target groups, timing staffing and choice of technique(s).

On what basis can one determine a project to be "better" than another? This entails choosing evaluation criteria. The fundamental cost-benefit criterion embodied in the Net Present Value (NPV) has already been introduced above. The "present" commonly signifies a point in time immediately preceding the initiation of a project (Gittinger, 1982), but nothing prevents the analyst from choosing another point in time. The point chosen will not affect the ranking of projects, only the size of the NPV (Layard and Walters, 1976).

Other evaluation criteria are also used. The Internal Rate of Return (IRR) is the interest that a project can pay for the resources used in the project and still recover its investment and operating expenses. This can be compared with a national norm (if there is one) that projects are expected to reach; a "cut-off rate". The Benefit-Cost Ratio (BCR) is the present value of all benefits divided by the value today of all costs:

$$BCR = \sum_t B_t(1+r)^{-t} / \sum_t C_t(1+r)^{-t}$$

If this is more than one, the project makes a social surplus.

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1. In the USA, an Executive Order from 1981 makes **all** major regulations subject to "regulatory impact analysis", including cost-benefit assessment. However, the USA is unique in its official use of this technique. (OECD, 1989).

The choice of appropriate criteria will depend on whether there is a funding constraint, and whether the projects being compared are independent or mutually exclusive. However, the NPV is safe to use. We will not go into the details of when each of these criteria are useful and what their limitations are.[2] It should only be noted that using IRR to rank projects may give the wrong result. The IRR only measures the rate of net benefits generated by the project, but not their size. Thus, a small but high-yielding project could take precedence over a competitor yielding greater net benefits but at a lower rate. There are also cases where a unique IRR cannot be determined. Using the BCR to compare projects of different sizes may also give an incorrect signal to policy makers. However, it is useful when comparing alternative uses of a given budget which is exhausted in all alternatives.

Applications to Project Analysis

Of the 20 reviewed studies, 16 use NPV, 10 BCR and 9 IRR as a criterion for project worth. Frequently, two (8 studies) or three (4 studies) criteria are calculated. Sometimes conflicting signals from different criteria are not clearly resolved when ranking various alternatives. Figueroa and Garduno (1980, p. 142) appear to be counting "scores" according to the three criteria calculated. Although their ranking coincides with the one given by NPV, this appears to be a fortunate circumstance rather than an analytical deduction. Similarly, Gauchon and Lok (1973, p. 35) entertain a complicated elimination process that appears to rank according to multiple criteria.

Reference is sometimes made to pay-back periods (6, 12, 13, 14, 20). Kislova (1979) is the only study reviewed that does not use any of the discounted measures, but **only** pay-back period as a criterion of project performance. Although this should never serve as a social criterion, it may have some pedagogical value if used as a tool for presentation rather than project selection.

2. Gittinger (1982, pp. 299-361) gives an introduction and Helmers (1979, pp. 91-111) penetrates the issue further.

4.4 Income Distribution

A fundamental basis for CBA is the assumption that people themselves are generally the best judges of their own welfare. Their preferences are reflected in their willingness to pay (WTP) for improvements or to avoid deteriorations. This immediately raises the concern that these measures reflect the prevailing distribution of income. If this is seen as unsound - and most people would argue that it is in developing countries - there seems to be a case for introducing a corrective device. This is referred to as "distributional weights". The treatment of income distribution has received extensive discussion among academic economists. Two broad approaches can be distinguished:

(1) To confine the economic analysis to one of efficiency rather than equity. Efficiency is determined by maximizing NPV, weighing each monetary unit with unity, regardless of to whom it accrues. Possibly, the distribution of significant costs and benefits among income groups (households or regions) is presented, but one refrains, according to this approach, from introducing explicit distributional weights.[3]

(2) To introduce distributional weights explicitly.[4] This could be done to illustrate switching values, i.e. values on the income distribution weights that make the decision switch from "accept" to "reject" according to some evaluation criteria. The weights are to be derived by repeatedly facing decision-makers with the necessity to weigh efficiency and equity together.[5]

The main arguments behind these positions are reviewed briefly here. First, it has been argued that distributional objectives are better met by general fiscal policy than by project selection and design.

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3. See e.g. Harberger (1971), Gittinger (1982) and Mishan (1982).
4. Empirical illustrations are given in Helmers (1979, ch 10), Little and Mirrlees (1974, pp. 238-242) and Squire and van der Tak (1975, pp. 63-67).
5. The most influential works - Dasgupta et al (1972) and Little and Mirrlees (1974) - have similar ideas in this respect. See also Cooper (1980), Helmers (1979), Irvin (1978), Pearce and Nash (1981), Squire and van der Tak (1975) and Weisbrod (1968) among others.

However, this is a doubtful argument given the administrative realities of Third World countries. Tax collection is often inefficient and there are political constraints to what can be achieved.

Second, it has been argued that there is no "objective" way of weighting one group against another. Thus, the exercise becomes arbitrary and may bring CBA into disrepute. However, the traditional mode of weighing together WTP implicitly weighs all dollars equally, regardless of to whom they accrue, so there is no escape from value judgments. It is then better to present such judgments openly and see what difference they make.

Third, the distribution of costs and benefits among various groups is very difficult to detect. This is indeed a problem, and may be the major reason why so many empirical analyses simply disregard the issue. But this is not a valid excuse for not trying and we at least need to acknowledge the importance of the problem.

Fourth, it may be considered naive to assume that decision-makers would explicitly pronounce weights to be given to various income groups or regions, and to be used consistently for making project decisions. This is a valid point. There are no observed instances where a government has adopted systematic social weights in practice. However, this should not prevent the analyst from illustrating the use of such weights.

Finally, it has also been argued, even by proponents of social weights, that their naive use can make inefficient projects pass on distributive criteria. Therefore, Helmers (1979) has suggested that only projects showing an acceptable economic rate of return **before** social weighing should be subject to income distribution analysis. However, this assumes that a clear distinction can be made between efficiency and equity. As argued above, any aggregation of individual welfare changes requires some judgement about how they should be added, thus making such a separation logically impossible.[6]

In summary, good arguments have been raised for the inclusion of income distribution as a concern in CBA.

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6. See Mäler (1985) for a formal discussion.

This is also the view taken here. Let us now turn to its application in relation to analysis of land improvement projects.

Applications to Project Analysis

The result on this point is meagre. Only four studies (1, 11, 19 and 20) provide any discussion at all. Especially when analyzing projects in developing countries, distributional aspects should at least be identified. Surprisingly, the most extensive treatments of income distribution concern projects in Australia and New Zealand! No study has progressed to stage (3) above. Governments may be unwilling to provide guidance in terms of social weights, because this would be politically delicate.

Abelson (1, pp. 100-101) considers separately the effects in five categories: (1) landholders within the project area taken as a collective, (2) government, (3) the local region, (4) the nation (Australia) and, (5) foreign consumers. Effects are traced out by considering taxation, price changes and secondary benefits. The most interesting result is that foreign consumers receive a substantial portion of the benefits because of lower wool prices, due to the considerably increased output from the project area. This is not a typical result for a soil and water conservation project, but it illustrates the need to consider such effects when evaluating large projects when the country is not a price-taker on the world market for the goods affected.

Harris (11, pp. 78-89) separates (a) three kinds of farmers according to geographical region in New Zealand (high country, hill and lowland) and (b) a common national perspective. The rates of return are found to be higher for the farmers than for the nation because of public subsidies, and to vary considerably depending on region. This finding is the basis for a revised subsidy scheme which there is reason to return to below.

Veloz et al (19, pp. 150-153) make a 2 x 4 division: the private and the social perspective is applied to four land (=slope) categories for which different conservation measures are prescribed. Economic and financial net benefits per hectare for each kind are calculated. It is

found that farmers in three of the categories stand to lose from the prescribed conservation measures, and they are therefore unlikely to be accepted by them. Social profitability, however, is higher because there are positive external effects - decreased siltation of a dam downstream.

Wiggins (20, pp. 413-414) discusses two groups loosely referred to as "large farmers" and "small farmers". He remarks that it would be most efficient to give first priority to the gently sloping lands which are owned by larger farmers, whereas social consideration speak in favour of promoting conservation among the rural poor. Thus, he informally introduces distributional weights on top of the traditional NPV calculation.

4.5 Identification of Costs and Benefits

A "cost" is any social disadvantage and a benefit consequently any social advantage, according to the definition of CBA above. The **with and without** project principle is fundamental to the identification of relevant items (McKean, 1958). Listing **financial cost** items, on the basis of market prices, is usually straightforward, especially ex-post. It is when financial costs are to be adjusted and amended to capture economic costs, based on WTP, that problems occur. This will be addressed below under "valuation".

Benefit identification may be more difficult, even conceptually. There are pitfalls of sunk costs and potential double counting of benefits. It also entails determining the geographical limitations to be drawn around a project area and determining what impacts are due to the project, and what are exogenously determined. If maize production in area X has increased Y percent in ten years, is this due to rainfall, the use of exogenously introduced machinery or project induced changes? Are the secondary benefits the result of re-allocation of fully utilized factors of production, or do they represent a real addition to national output? In the former case, there is no need to account for "secondary benefits", unless there is a specific premium due because of a goal to achieve a "better regional balance". However, if idle resources are pulled out to produce goods and services, it amounts to a genuine benefit item. (McKean, 1958).

A common mistake in the appraisal situation is to limit unnecessarily the number of alternatives considered. Often, only one single project idea is analysed, and other potential costs and benefits are not even identified (Birgegård, 1975). A thorough CBA critically looks at the available alternatives and may therefore result in a much more interesting conclusion than simply "accept" or "reject".

Applications to Project Analysis

Although the identification of benefit items is generally quite sound in the reviewed studies, three cases of controversy were identified in relation to the study by

Das and Singh (1980). First, they identify as a benefit item the protection of capital investment in a dam. However, this historical investment is a "sunk cost", whose level is unaffected by current choice of soil conservation measures to counter siltation of the dam. It is the willingness to pay for the commodities lost through dam siltation (energy, water ...) that is of relevance when evaluating the worth of current soil conservation efforts.

Second, there is no need to assign a separate "capital value" to agricultural land in addition to the value of increased yield as a result of conservation. If markets work well, the increased value of land is simply a reflection of the discounted value of raised yields. Even if markets do not work well, one should not double-count yield values and capital values.

Third, there is an obscurity in the treatment of employment. Information about created man-days may be of great interest for political decision-makers, as increased employment is generally a top national priority. However, it is misleading to list "employment benefits" as the sum of salaries. Employment is a **cost** to the project. This cost may be diminished towards zero depending on the availability of alternative job opportunities - properly dealt with under the heading of "valuation". It is also a cost which may have worthwhile distributional aspects. This should then be discussed under its appropriate heading.

As for the identification of alternative costs and benefits, the ex-ante studies (1, 3, 4, 5, 17, 19, 20) contain successful demonstrations that several options can be analysed and compared within a single CBA. Christophersen and Karch (1988) is a particularly good example in this respect.

4.6 Quantification of Costs and Benefits

While the cost side often poses no major difficulties, the benefit side presents considerable problems in the context of land degradation. The underlying ecological relationships are often complex. The issue can be subdivided into (a) clarifying the extent of land degradation and (b) determining its impact on the production of the ecosystem.

On the first point, there are well-established - although still controversial - ways of calculating the extent of soil loss based on a list of variables pertaining to the climate and the soil. The core method is the Universal Soil Loss Equation (USLE) and adaptations thereof.[1] In brief, soil loss[2] is calculated according to the following formula:

$$A = R \times K \times L \times S \times C \times P$$

where

A = soil loss in t/ha
R = rainfall erosivity index
K = soil erodibility factor
L = the length factor
S = the slope factor
C = crop management factor
P = conservation practice factor

The R factor measures the force with which the rains during a specific time period impacts the soil. It is a an index derived from the kinetic energy of rain and the maximum 30-minute intensity of the rainfall. This measure can be derived for individual rainstorms and summed to arrive at weekly, monthly or annual values. The K factor

1. The original reference is Wischmeier and Smith (1978). The presentation here is based on Hudson (1986).
2. Soil loss is not synonymous with erosion since there is deposition in depressions, along field boundaries and so on. The difference grows with the size of the area considered: the earth as a whole does not lose any soil due to erosion. It has therefore been suggested that "loss" in the USLE should be replaced with "displacement" (Cook, 1982).

measures the amount of soil lost in t/ha per unit of erosivity (R), given certain standard conditions.

The L and S factors are brought in to allow for the fact that the basic soil loss equation was estimated under certain standardized plot conditions. L is a dimensionless factor measuring the ratio of soil loss from a field with a specified length and that of a plot with 22.6 meters. Similarly, the S, or slope factor is a dimensionless ratio relating the soil loss under a particular slope to the standard slope of 9 percent. These two factors are often combined in a joint diagram, where the LS index can be read off. At the standardized values, the index is = 1.0.

The C, or crop management factor is again a dimensionless ratio comparing the soil loss from a specific field with that one cultivated under specified standard conditions. Finally, the P factor (conservation practice) is a dimensionless ratio comparing the soil loss with that coming from a field with no conservation practice at all. Thus, it has a maximum of 1.0.

In spite of its grand name, the USLE is widely recognized as having limitations. It was developed to predict soil loss from sheet and rill erosion (not gullying). It pertains only to rainfall, not wind erosion, and it was calibrated on data from the USA. Therefore, it has been both used and abused to draw conclusions regarding the rate of erosion in many different environments (Wischmeier, 1976).

Turning to the second point about linking assessed erosion to productivity, the picture is discouraging. As discussed more in detail in chapter 2, it is generally acknowledged how little we know of erosion-yield relationships. Yet, reasonable assumptions regarding the with/without project level of output of crops, fuelwood, grasses, livestock products etc. are necessary components of a CBA of a conservation project.

The Erosion Productivity Impact Calculator (EPIC) is probably the most elaborate such model yet constructed for the calculation of erosion-induced effects on production (Williams et al, 1984). The EPIC model includes components of weather simulation, hydrology,

erosion, sedimentation, nutrient cycling, plant growth, tillage, soil temperatures, farm household finances and plant environment control. What limits the use of EPIC is its great complexity and a need for data that cannot be satisfied in the average developing country context. The model also requires a team of advanced personnel to run them and to sensibly interpret the results. It is not known whether EPIC has ever been used in a developing country context.[3]

Returning back to the micro-level problem of quantifying the bases for a CBA, one can identify five major ways of estimating these variables, namely through:

(1) farmer interviews
(2) inference from external statistical sources
(3) informal expert advice
(4) local crop samples
(5) local experiments

A few remarks in principle will be made here. First, farmer interviews have a number of obvious problems. If a before/after conservation format is used, exogenous factors such as rainfall, temperature and so on will not be eliminated. Recall may be difficult and inaccurate if periods are long. Even if short, farmers may not record with the accuracy needed for statistical inference. Interviewer bias may also play a role, as even the most independent enumerator is likely to be identified with the government or the project.

Second, external statistical sources may pertain to other geographical regions where climate and soils are quite different. Uncritical inference to such sources may lead one quite astray as erosion-yield response rates are quite area specific and may vary with a factor of 1:20 or even more (Stocking and Peake, 1985). Cross-section studies, comparing yields over time from project plots with control plots would be preferable, but the evidence for developing country circumstances is extremely limited.

Third, informal expert advice may be of quite varying quality. While never wrong to solicit such opinions,

3. However, it has been used to test the existence of on-site cost market failures in the USA (Miranda, 1990).

their bases are sometimes obscure, and estimates may be influenced by irrelevant considerations.

Fourth, local crop sampling giving "objective" measurements is preferable in principle to the other sources. However, crop sampling is complicated, costly and time consuming. The issue is discussed further in chapter 5.

Finally, local experiments can be used as a short-cut in order to simulate long-term soil loss - yield relationships. This entails artificial desurfacing of plots in order to regress the resulting yield on topsoil depth and perhaps other variables. This type of experiment accounts for almost 40 percent of some 150 erosion-productivity studies reported on in Stocking and Peake (1985). While time- saving, this practice has its own serious problems. Natural erosion and artificial desurfacing are quite different processes. The former is a selective and more detrimental process. Thus, desurfacing can only give a lower bound to the impact of soil erosion.

Applications to Project Analysis

Not surprisingly, quantification of output in the with/without situation is often a weak part in CBA studies of soil and water conservation projects. Using the categorization introduced above, the approaches used in the empirical studies can be summarized as in table 4.2.

Table 4.2 Approaches to Quantification of Benefits

	Studies	(No.)
1. Farmer interviews:	1,5,8,9,10,12,13,16	(8)
2. External literature source:	2,11,15,17,19,20	(6)
3. Expert advice:	1,2,5,6,14	(5)
4. Local crop samples:	9,13	(2)
5. Local experiments:	7,18	(2)

Some sources have used several approaches. Studies 3 and 4 have been impossible to categorize due to unclear references. Studies 10 and 16 appear with an implicit question mark, as the nature of their farmer surveys is not explained.

Quantitative estimates are sometimes obscurely referred to as based on "local experience" or similar. Sometimes it is based on a very short period of observation where confounding factors (rainfall, other farm improvements etc.) have been eliminated on an ad-hoc basis. Estimation periods used for farm surveys and sample sizes are sometimes left un-specified. Sometimes statistically non-significant values are used to derive conclusions with unwarranted certainty. There are several cases where the analyst admits to basing the computations on weak quantitative evidence. This is at times forgotten in the summary - the only part that decision-makers may read.

Of particular interest are the studies that use local crop sampling or local experiments as a method, as this appears to be the strongest methods based on theoretical considerations. Gauchon (1976) reports that the project was suddenly terminated. Thus, technical data were not collected as planned. However, a limited survey was made of sites with various topsoil depths of 0, 25 and 75 cm respectively. This was to give an indication of the topsoil depth-yield function, which was **linearly** interpolated to cover other depths. Further statistical details are not known.

Holmberg (1985) used a two-pronged approach. Field samples were used to determine with/without SWC differences in yield levels, while interviews were used to determine the average base level. The random sample consisted of 65 with and 16 farmers without SWC measures on their farms. Monitoring is reported from three seasons, but only one is in fact used for deriving the figures for the relative difference in yield (Ibid., p. 31). The other seasons are found to be deviating too much from an average situation - an unconvincing argument for their elimination. Holmberg admits that his evidence does not constitute statistical proof for a difference

with/without soil conservation (p. 27). Yet, he concludes that "... it appears that soil conservation both from the farmer's point of view and the society's is a project with high return worth investing in." (Ibid., p.50).

Figueroa and Garduno (1980) have carried out experiments with five types of terraces and one check plot on 5 ha of land. Erosion and yields were measured in 1976 and 1977. However, as the authors admit, there was **not** a statistically significant difference between the plots in terms of soil loss, grain and straw yields (p.129).

Nobe and Seckler (1979) report on artificial removing of soil in six steps on 12 plots. Maize yield was observed during one season, and a freehand regression curve fitted to observations. The relationship was found to be highly non-linear.

In summary, the four studies reviewed more in detail offer a very limited support for the conclusions drawn. Apart from the theoretical consideration previously discussed, the main weakness is that they cover too short a period. As the relative difference between with/without fields will vary strongly, this is troublesome.

As a separate point, one also notes that several benefits are identified as intangibles, i.e. the analyst is unable to quantify the variable in monetary terms. Examples (varying from study to study) concern flood mitigation, improved water quality, research benefits, secondary benefits to the community and the impact of erosion on yield. There are several cases where this matter is of limited importance. If alternative conservation projects with similar intangibles are compared, the quantifiable variables may be sufficient to choose the best one anyway. In other cases, just knowing the sign of the intangible variables is sufficient to strengthen an evaluation based on tangible items. In remaining cases, the CBA has at least specified the basis for judgment - an important gain.

4.7 Valuation in Economic Prices

The rationale behind economic valuation - as opposed to financial valuation, using market prices - is derived in chapter 2. Market and government failures are the key concepts under which more specific points are organized. First, markets are not complete in their valuation of all relevant impacts of land degradation. This is of particular concern when managing communal grazing lands, and where crop land markets are poorly developed. There are also cases when the relevant decision-maker would not accept market prices as fair reflections of WTP, due to some distortion in the market. In some cases the underlying income distribution is not considered as acceptable and adjustments are called for. After all, WTP is based on ability to pay.

Second, there are government failures. Through its many interventions in the economy, government will affect - intentionally or unintentionally - the financial environment of the land users. This may also affect their adoption of land rehabilitation measures, as a CBA would be able to illustrate. Thus, the aim is to map the diversion between financial and economic prices, as well as to establish economic prices where no financial prices exist. This is a complex field which we cannot cover completely here, but there are a few special points to watch for in connection with land rehabilitation projects in developing countries.

First, there is the issue of shadow pricing of labour. Land rehabilitation projects are often quite labour intensive. An important reason why social profitability is sometimes higher than private profitability is that the opportunity cost of unskilled labour used in conservation projects is lower than the market wage. What exact fraction of the market wage to use is an empirical question. This can only be settled after some research into the local labour market. National guidelines, if they exist, may facilitate consistent analysis across projects.

Second, there is the issue of the foreign exchange rate. The official exchange rate may be an unsuitable reflection of actual willingness to pay for foreign exchange, as many developing countries maintain

overvalued domestic currencies. The existence of a black currency market in many LDCs is a strong indication of this. There are two alternative ways of approaching this issue. The "UNIDO-approach" (Dasgupta et al, 1972) multiplies the official value of foreign exchange with a foreign exchange premium, to arrive at a shadow exchange rate. Conversely, the "Little-Mirrlees approach" (1974) adjusts the value of domestic non-traded items with the foreign exchange premium. The most simple form of this is to take the ratio of the value of all traded items in border prices divided by the value at domestic prices to arrive at a Standard Conversion Factor for the economy. Both methods are perfectly legitimate, but reflect different units of account.

Third, land rehabilitation projects will often entail impacts far into the future. Real prices may change considerably in decades. It is therefore important to account for such future changes in order to properly evaluate the project's impact.

Applications to Project Analysis

The general picture is that the 20 studies surveyed exhibit a range from carefully reasoned shadow pricing and price forecasts (1, 2, 20), via its partial consideration (8, 9, 11-13, 15, 17, 19) to total, often unexplained, neglect of shadow pricing (3-7, 10, 14, 16, 18) and obscure assumptions about future prices.

First, as for the shadow wage rate for unskilled labour. There are examples which cover the full range from 0 percent to 120 percent of the market wage. It does not appear that any profound research of the local labour markets has gone into the studies. Government advice is never referred to on this point.

The second more specific observation concerns the treatment of the foreign exchange rate. This is applied in, probably, five studies. Anderson (1987, pp. 61-62) avoids "... the intricacies of estimating the shadow exchange rate ...", but asserts that "... it was widely agreed that the Standard Conversion Factor.[1] was then

1. SCF is the reciprocal of the shadow exchange rate. Thus, instead of about 1 Naira to the US dollar, Anderson calculates with 1/0.35 = 2.86 Naira.

about 0.35." Gauchon and Lok (1973) deal more extensively with the use of the shadow exchange rate. The correction here is minor; only a 7 percent devaluation of the South Korean currency. The source is the Bank of Korea, which apparently uses a public shadow rate.

Harris (1982) refers to the New Zealand Ministry of Agriculture for "composite coefficients" reflecting the foreign exchange content of various items. The resulting changes are small here as well: 4-9 percent. It is note clear from this source exactly how the rate of adjustment was arrived at, but at least public advice provides for some consistency across analyses. Hedfors (1981, p. 17) says that for maize "... border prices will be applied to adjust and reflect the premium of exchange with the world market." However, it is not clear what adjustment is actually made. Holmberg (1985) has an identical wording, but again, there is no explicit sign of an adjustment to the official exchange rate when converting the import price of maize into Kenyan Shillings.

Veloz (1985, p. 151) is more explicit in using the following formula for conversion:[2]

$$W_i = P_i * ((E_i * 1.67) + (Q_i - E_i))/Q_i$$

subject to $E_i > 0$

where

W = social value of one unit of commodity i
i = commodity index
E = export quantity of the commodity
Q = domestic production quantity of the commodity
P = market price
1.67 = the ratio of "free market" exchange rate over official exchange rate, 1982-83.

This amounts to a weighing of the export share of the commodity with the exchange rate premium of 67 percent. The empirical basis for the determination of the "free" rate is not specified. To the extent that the black market rate was used, this may not be indicative of a

2. The formula appears in Veloz et al (1985) with a "*" (times) sign where the "+" appears here. It is difficult to interpret this as anything but a typographical error.

genuinely free market, if considerable risks are involved in exchanging.

Finally, Wiggins (1980, p. 410) uses a 10 percent foreign exchange premium with the argument that: "This reflects El Salvador's persistent deficit on current account trading since 1973." Both the logic and quantitative relationship between the deficit and the premium value are obscure. A current account deficit is theoretically consistent with a free foreign exchange market reflecting actual WTP. If there is a persistent capital account surplus (due to e.g. foreign aid), the official exchange rate could represent a long-term equilibrium. Even if there is a persistent deficit in the balance of payment in aggregate, how does it take us to 10 percent?

A third observation is that **real prices** are often taken as constant over decades without further discussion. When dealing with agricultural commodities with unstable real prices, it would be reasonable to at least have some discussion on real price trends and variance - as done well in studies 1 and 2, and discussed to some extent in 8, 15 and 20.

In conclusion, there are a few carefully reasoned studies to learn from in terms of valuations; Abelson (1979), Anderson (1987) and Wiggins (1980) in particular. However, many other studies leave the reader with insufficient information as to why and how a particular adjustment was done.

4.8 Discounting

Few issues in environmental economics have stirred so much heated debate as the discounting of future costs and benefits to present values. Many economists have in fact looked upon discounting as, at least partially, an expression of human irrationality. Already Pigou (1920) noted that many socially worthwhile projects were

> "... handicapped by the slackness of desire towards distant satisfactions. The same slackness is responsible for that over-hasty exploitation of stored gifts of nature, which must make it harder for future generations to obtain supplies of important commodities." (Ibid., pp. 27-8).

However, Pigou did **not** advocate a zero discount rate. Others have gone further in completing the rejection of discounting:

> "Devotion to economic discounting is suicidal. How soon is it so? 'In the long run,' an economist would say, since disaster is more than five years off." (Hardin, 1977, p. 113).

There are two fundamentally different approaches to the choice of a social discount rate. The first approach is that **market rates are in principle unsuitable** as determinants of the social discount rate. The second approach is that consumer sovereignty should indeed direct us to **use market rates** that reflect the preferences of individuals. The problem is then one of finding the appropriate rate from market data.

Representative of the first approach is the influential work of Dasgupta et al (1972, p. 158):

> "... to infer a social rate of discount from rates of interest that individuals earn on what they save or pay for what they borrow is a misplaced application of the theory of consumer choice."

They argue that the doctrine of consumer sovereignty brakes down in an intertemporal context, and present the following arguments for treating the discount rate as an **unknown** in project analysis:

(1) There is uncertainty about the future and impossibility for individuals to learn from testing of various consumption plans over life;

(2) Individuals are not able to express through the market their preference for social investments as opposed to their own private investment.

Turning to the second approach, one has to analyze the markets to acquire some data on the consumers' preferences. In an idealized world of perfect markets with no transaction costs, no uncertainty, no taxes and no credit restrictions, the market rate of interest would equal both the marginal rate of return to investments and the consumption rate of interest for individuals. In this world, it would not matter whether a particular project replaced consumption or other investment or a mixture of the two, the appropriate rate would be the same. (Lind, 1982).

Real world conditions such as taxes and regulations introduce a multitude of interest rates on the market and one must ask which the appropriate one would be for social discounting. The answer would depend on the alternative considered, i.e. the displacement impact on consumption and investment respectively. If consumption is displaced, the empirical search entails looking at real after tax returns to the investor on risk-free bonds etc. If investment is displaced, the empirical search entails collecting evidence of real before tax profits on alternative investments opportunities.

An additional complication is that an investment decision today not only affects current values of consumption and investment, but these variables at all future times. Apparently, the information required for a correct accounting of this would be considerable, including the rates of return and division of consumption and re-investment at all future times within the time horizon considered for the options under consideration.

Lind (1982) opts for the procedure to (a) set the social discount rate equal to the social rate of time preference, as revealed by their consumption rates of interest and (b) to account separately for the

displacement or stimulation impact on private investment by shadow pricing of capital. This converts the value of investment into consumption units.

An attempt to briefly assess the approaches to discounting follows. First, there is a choice between retaining the view of consumer sovereignty also regarding intertemporal choice, and a more "paternalistic" view of leaving the social discount rate to be determined by the person(s) controlling the project. Second, if the approach is taken that market returns to saving and investment matter, what should the appropriate rate be?

Public choice theory has dented the image of government as a benevolent social guardian. Leaving the setting of the social discount rate entirely up to decision-makers within government may in fact leave it up to a particular interest group that occupies a key position in government. An important issue is whether the choice of rate would be explicit and consistent or implicit and ad-hoc. The latter would open up a rich field for manipulation and promotion of vested interests. The view taken here is that the decision-makers in fact ought to be concerned with the alternatives available, i.e. the rate of return of displaced opportunities, be it consumption or investment. Lind's procedure appears logically clear and consistent with the use of consumption as the numeraire. It will be accepted here as a theoretical norm to be contrasted with empirical applications.

Given these guidelines in principle, few authors offer any numerical advice as to an appropriate social discount rate.[3] Such advice, of course, should be taken to reflect specific conditions of time and place. Helmers (1979) arrives at a figure of 7-8 percent, assuming a consumption growth rate of 2-3 percent. Little and Mirrlees (1974) suggest a low of 4-5 percent (or the return on the international money market) and a high of 10-15 percent for the more advanced LDCs. Lind (1982) suggests that a typical government project in the USA should use a rate of 4.6 percent, whereas energy

3. Although one is grateful for the priceless advice that "the ARI (the accounting rate of interest) need not be so high as to frighten ministers." (Little and Mirrlees, 1974, p. 294).

investments, because of their insurance value and their long-term nature, should use a 3 percent rate. The World Bank uses 10 percent as a norm for its development projects (Markandya and Pearce, 1988).

"Environmental" Adjustments of the Rate of Discount?[4]

What has been said so far concerns discounting in general. The case has also been made (1) that the **general** rate of discount should be adjusted to reflect environmental concerns or (2) that there are special considerations in the case of **environmental** projects, calling for an adjustment in such cases.

Starting with the first and most general issue, the effect of a general lowering of the discount rate because of environmental concerns may have the ironic effect of producing a result opposite to the intended. A lower rate will make more projects produce a positive net present value. This may cause an increase in natural resource degradation because of increased investment activity.

On the more specific issue of discounting environmental impacts separately, it is sometimes claimed that environmental effects are particularly prone to underestimation. Therefore, these should be discounted at a particularly **low** rate (Cooper, 1981). A related argument is that the discount rate should be adjusted downwards to reflect environmental risks (Brown, 1983). Environmental concerns have also led to suggestions for a **high** rate to reflect the risk of environmental damage. Discounting the costs of projects with a particularly low rate is consistent with discounting the benefits with a particularly high rate (Prince, 1985).

First, it is true that our knowledge of environmental processes, such as land degradation, is rather limited, especially regarding long-run effects. But is this a concern for the choice of the social discount rate? It appears more reasonable that this is a concern at the stages when costs and benefits are quantified and valued, and when uncertainty and risk is considered. If there is reason to believe that environmental damage may have been underestimated, one should adjust the base case

4. Several points made in this section largely coincide with a discussion in Markandya and Pearce (1988).

assumptions, or test other estimates and see how this effects the net benefit. This is a more explicit way of adjustment than to manipulate the discount rate.

Second, there is something odd about trying to separate "environmental" effects from other effects on human welfare. Even if that could be done in practice - which would be difficult - it would entail valuing the same losses in income differently. Consider e.g. a loss of USD 100 in income due to losses in crop yield as a result of erosion and the same loss due to the crop rotting because of lack of appropriate storage and transport to the market. Why discount the one loss differently from the other?

Finally, the suggestion to apply a particularly high discount rate to account for environmental concerns implies that risk grows progressively over time. This may not be an appropriate assumption. On the contrary, the future may offer opportunities to more effectively counter effects that are environmentally damaging.

In summary, the arguments for manipulating the discount rate either generally or specifically pertaining to environmental impacts, because of environmental concerns are not convincing. It is time to proceed to the actual use of discounting in analyses of conservation projects.

Applications to Project Analysis

Most authors (11 studies) do not provide any kind of rationale for their choice of discount rate. Sometimes a passing reference is made to "social opportunity cost of capital" (1, 7, 20) or advice from an authoritative body (8, 9). The empirical basis for the opportunity cost rates remain unclear. Official advice on this point could come from a central authority on economic planning, but seems to be hard to come by in reality. There are no signs of a discussion of marginal propensity to save out of project benefits, the distribution of displacement by the particular investment and of shadow pricing of capital. It appears that particular "environmental" considerations have not played any role in the choice of a particular rate. At least, there is no explicit discussion on this point.

The absence of a well documented empirical basis for the rate applied may not be serious if a consistent rate is applied across all relevant project alternatives, given institutional constraints. There is generally a lack of consistent government or donor guidance on this particular point. However, there appears to be an informal consensus around an interval of "reasonable" rates. As long as this is applied, and sensitivity tested, the problem is not extremely serious. The table below reflects the rates actually chosen.

Table 4.3 Real Social Discount Rates

Rate interval:	<5	5-10	11-15	16-20	Total
No. of studies	1	14	3	1	19

One study (16) apply IRRs only and therefore does not appear in the table above. Still, a cut-off rate would have to be established for comparison with this IRR. Regardless of project location, rates chosen for economic analysis are fairly well clustered in the 5-10 percent interval, with 10 percent as the most frequent choice. Although not explicitly referred to, the World Bank rate may have served as a point of reference. There is no sign that a changing social rate of discount has ever been considered.

4.9 Time Horizon

In principle, any length of time could be considered in a CBA. The lower the discount rate applied, the more important are the long-term cost and benefits. One should not expect uniformity in years, but rather of principle; that the **economic** life-time of a project be considered. This is the entire time that the project affects the economic environment, as opposed to project team involvement which may be considerably shorter. In the case of soil conservation projects, this means making assumptions regarding maintenance of structures and improved land management. Maintenance has been a persistent weakness in documented projects, perhaps because of poor local involvement in decision-making. An additional factor is the heavy labour requirement for maintenance of soil structures (Stocking and Abel, 1989). Therefore, the economic life of projects has often been short.

Applications to Project Analysis

The time horizon chosen is usually 10-20 years (10 studies) or 25-30 years (4 studies). A few studies (2, 5 and 8) use 50 or 60 years, while the two remaining are not clear on this point. Most authors do not provide any reason for their choice of time horizon. The testing of minimum pay-back period is mentioned. As previously discussed, this is a dubious criterion.

The importance of this point should not be exaggerated. Extending the life-time of a project from 30 to 50 years may have a negligent impact on the overall result, particularly when discount rates such as 10 percent or above are used. As illustrated above, most analysts use a rate of 5-10 percent. Simple sensitivity testing could show the degree of importance of this variable, which is also done in a few cases.

4.10 Risk and Uncertainty

Formally, a distinction could be made between "risk" and "uncertainty"; risk being "quantifiable uncertainty". In practice, there is a spectrum of more or less uncertain variables such as the effect on crop yield of erosion and the price of crops over the years to come. Pure uncertainty (no possibility of assigning probabilities to various outcomes at all) is a very unusual situation. The subjects of risk and uncertainty will be treated as one in this context.

Risk implies that the NPV of a project is not a single number, but rather a set of values with an associated probability distribution. It would useful to know not only the distribution of NPVs, but also the attached distribution of **utilities**. The expected value of utility could then be obtained theoretically by multiplying the utilities of various outcomes with their probabilities and summarizing them.

The nature of the utilities that are associated with the various outcomes reflects the preferences of the individual and correspond to the attitude toward risk. Consider the game of betting USD 50 for the chance of gaining USD 100 with a 50 percent chance and getting USD 0 with a 50 percent chance. Thus, the expected net gain is zero. If the individual is willing to accept this game he is said to be risk-neutral, while if he declines the offer he is said to be risk-averse. If there is risk-aversion, this entails a cost which can be defined as follows. The **certainty equivalent** is the amount that received with absolute certainty is considered equivalent to an alternative probability distribution of outcomes. The cost of risk is the difference between the expected value of the probability distribution and the certainty equivalent. Thus, the cost of risk-bearing vanishes from a risk-neutral perspective.

It seems that most individuals are risk-averse. Another question however, is whether society as a whole should apply the same perspective. The answer depends on the nature of the project. Assume that the real net present value of the project is not correlated with the general state of the economy. This means that there is no systematic covariation between the outcome of the project

and the national income. Then it can be shown that sufficient risk spreading, e.g. through general taxation, would reduce the cost of risk-bearing. If there are enough individuals, society should be risk neutral. (Arrow and Lind, 1970).

An important qualification has been made in the case of environmental effects. The costs of adverse effects may in practice be borne not by the general taxpayer but by individuals directly exposed to environmental degradation. The salient feature is that one person's risk is not diluted by more people sharing this risk: if I die because of air pollution due to the expansion of coal fired electricity generation, this does not diminish the risk for others of following my path. This characteristic also invalidates the position of risk neutrality from society's point of view.[5]

How does this argument relate to soil conservation? If one assumes that resources are invested into land improvement with the expectation of return (repayment) to the lenders, the risk from an economic perspective is borne in the diluted manner that fits the Arrow-Lind theorem, as the total project cost is divided among a great number ot tax payers. However, a common case is that resources are transferred as a grant, and the risk of the donor is not one of income loss but rather one of moral an political disillusionment, which we will leave aside here. From a Third World government point of view, the argument of risk pooling would seem to apply: some projects work but others fail. On balance, there may still be progress in improving general food security. However, if failures are extensive, the loss of production potential may seriously affect agricultural capacity and put future welfare at risk even on a national scale.

Turning to the perspective of the individual farmer, one should note that a land improvement project will often **reduce** risk for declining production for the farming household by installing protective structures. The risk of flooding will be diminished by storm drains in the upper part of the watershed, run-off is prevented to destroy crops by the construction of waterways and so on.

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5. This was first analyzed by Fisher (1973). For further elaboration, see Mäler (1985).

However, other components of the project may **increase** risk: the tree seedlings planted may be browsed by cattle, the hybrid seed introduced may be more sensitive to drought than the traditional (on average lower-yielding) variety, and so on. How these risks for loss of invested resources are absorbed is another matter, and will depend on specific project arrangements. The extent of individual risk exposure will also vary from project to project.

Uncertainties in relation to land rehabilitation projects arise out of both factors internal to the project and external impacts. The difficulties of projecting production impacts of erosion/conservation have been discussed previously. The quality of staff can have a decisive influence on the project's performance. While some uncertainties decrease with the benefit of hindsight, i.e. when undertaking ex-post evaluation, others remain. In addition, the external environment may change considerably during the considered time period: prices of inputs and outputs are subject to market fluctuations and often government price regulations, taxation and trade restrictions.

Option Value and Quasi-Option Value

The discussion about uncertainty has given rise to a substantial literature about "option value", a term attributable to Weisbrod (1964). While this discussion may appear conceptually separable, it is not a numerical addition to the cost of uncertainty, but rather another way of discussing the same problem (Pearce and Nash, 1981). Weisbrod's observations have given rise to two types of analysis, which will be referred to as option value (OV) and quasi-option value (QOV) respectively.

Option value (OV) has been defined as (Cicchetti and Freeman, 1971):

$$OV = OP - E(CS)$$

where

OP = maximum option price
CS = consumer surplus

E = the expectancy operator

The option price is the maximum WTP for the right to purchase a good at a predetermined price in the future. Cicchetti and Freeman claimed that OV was positive in the presence of risk aversion coupled with either demand or supply uncertainty. Later work by Schmalensee (1972) and Bohm (1975) showed that option value could be either positive or negative. There will be no attempt here to review the substantial later literature that has appeared on this subject, but we will try to relate this concept to the problem of land degradation.

First, assume risk-aversion. This is justified from the typical Third World farming household perspective[6], but also from and economic perspective unless risks are diluted in accordance with the Arrow-Lind theorem. Second, assume that there is uncertainty about the future demand for and supply of soil (i.e. the products growing on that soil) in a given area. Demand uncertainty arises from lack of information on future population, food habits, agricultural technology and capacity to import food. Supply uncertainty stems from ignorance about soil losses and soil formation.

One the hand hand, we do not want to risk an overinvestment in saving a resource that might become more or less useless, while foregoing the return on alternative investments that may more efficiently enhance welfare. The option value could then be **negative** for the preservation of soil in this particular area. On the other hand, demand for soil is a rather stable and probably increasing feature of economic life in Third World countries. Given the relative certainty of future demand, and the severe consequences of underinvestment in land rehabilitation, it is plausible to ascribe a **positive** option value to such investments.

There is a related discussion regarding quasi-option value (QOV) that is of relevance here. Consider a situation signified by (a) a potential **irreversible** change and (b) where more **information** is forthcoming in

6. See e.g. Antle (1987), Binswanger (1980, 1982) and Dillon and Scandizzo (1978) for evidence regarding farmers in developing countries.

the future. The intuitively plausible result of analyzing such a situation is that there is a premium on waiting to retain the options open for later decisions. The conditional (on preventing irreversible change) ex-ante value of the additional information has been termed "quasi-option value" (Arrow and Fisher, 1974; Henry, 1974).

Because of its restrictive definition, the QOV is always non-negative: it is the value assigned to expected future information that will **not** be possible to utilize if a particular resource such as soil is lost. How does the concept of quasi-option value apply in the context of land degradation?

It appears to apply well in terms of irreversibility. For a specific area, lost soil is irreversibly lost, although it should be recalled that soil lost in a specific area can be deposited in another area, which is sometimes of considerable benefit to the latter. Since the rate of soil formation is extremely slow, often amounting to a fraction of a mm of soil layer per year, there is generally little compensation for the soil lost.[7] Fertilizer and improved techniques of land management can counter the detrimental effect, and even raise yield in spite of ongoing erosion, but there is still a hidden loss.

The concept of "quasi-option value" also applies in the sense that the information concerning the value of soil is growing over time. Should this indicate that the demand for soil resources should be higher than previously expected, or that the supply of soil in other areas is declining faster than previously thought, there is a value of having retained the option of utilizing a piece of land with greater potential in the future. It therefore appears that quasi-option value would apply to the analysis of land degradation.

In some cases, direct questioning is possible to obtain estimates using come form of contingent valuation method. However, the empirical difficulties of estimating option values are substantial (Reiling and Anderson 1980; Smith 1984; Mitchell and Carson, 1989) and this is not always practically feasible. Therefore, the commonly recommended

7. Some data on this is provided in chapter 5.

practical technique for dealing with uncertainty is **sensitivity testing.** This means varying the assumption on a particular point to see how sensitive the resulting value is to this change. Of particular interest are the switching values, i.e., the assumptions that will make the NPV change sign or the IRR to change position versus the established reference rate. This can be a useful way of identifying uncertainties that really matter, so as to direct future information gathering at narrowing down the probability distribution of these variables.

In summary, CBA cannot "solve" the eternal problem of uncertainty, but it has practical ways of demonstrating what various assumptions, based on the best available information, imply in terms of an activity's net worth.

Applications to Project Analysis

Most analysts (12 studies) provide at least some sensitivity testing. The most common elements of sensitivity testing are discount rates (6 studies) and time horizon (4 studies). In addition, a dispersed array of factors including shadow labour costs, crop prices and yield decline due to erosion are sometimes tested. Refined statistical probability analysis is not observed, but critical assumptions are modified according to simple rule of thumb testing: +/- 10 percent and similar.

An example of ambitious sensitivity analysis is Abelson (1979). He tests four different discount rates from 5 to 15 percent, three different time horizons from 20 to 40 years, three different price scenarios for agricultural products and two scenarios for livestock population levels. Wiggins (1980) is another example of generous, but selective sensitivity testing. Christophersen and Karch (1988) present not only a variety of alternative assumptions regarding key variables such as labour costs, discount rate and output prices, they also combine these in a matrix showing the synergy of couples of alternative assumptions.

There is no conceptual discussion in any of the reviewed studies in terms of option or quasi-option values. However, some authors vaguely refer to unspecified "preservation benefits" which may embody the same notions as discussed above. In any case, there are no attempts to

quantify anything that could be interpreted as an option or quasi-option value.

4.11 Policy Conclusions

Policies with direct or indirect impact on land degradation and rehabilitation have been the subject of extensive discussion in chapters 2 and 3. The reason why this theme is taken up again here, is that we are considering a specific kind of policy issue: that based on the results of a project CBA.

As noted in the discussion about evaluation criteria, decision-makers may want to consider other criteria than the distribution of NPVs for a project, possibly incorporating explicit equity weights. To the extent that such criteria have been clearly stated, they ought to be discussed in relation to the result of the formal CBA.

A major point in the policy analysis of a project CBA should concern the **differences** uncovered **between financial and economic perspectives** on the project. Leaving aside uncertainty and the the fact that households differ, let NPVe signify the economic net present value in the base case, and NPVf the financial result of a representative household. The focus here is only on the partial perspective of the project being analyzed, i.e. costs for any social intervention is disregarded for the time being. For the sake of simplicity, we will assume that only one project is being analyzed, and the issue is whether financial and economic results coincide. The situation may be divided into the following logical categories:

Table 4.4 Economic vs. Financial Profitability

	NPVe < 0	NPVe > 0
NPVf < 0:	I	II
NPVf > 0:	III	IV

Case I is simple in that both perspectives reveal the same message: the project under study is unprofitable. As long as farmers perceive that NPVf is negative for the land rehabilitation measures under study, there is no

case for government intervention to discourage such investments.

Case II is one where the signals are contradictory. The social return is higher, perhaps because of externalities that are not considered in the private calculations. Based on this partial analysis, the recommendation would be to provide subsidies or put a financial price on the externalities in order to achieve NPVf > 0.

Case III is again one of conflicting incentives. One may think of a highly subsidized scheme under analysis. Society makes a loss, but the farmers in the project area reap the benefits, resulting in exaggerated conservation measures. An appropriate response to this kind of a situation would be to diminish the subsidies provided.

Case IV shows that both perspectives perceive the project to be profitable, and private and social rationality will coincide at prevailing prices and institutional arrangements.

These stylized cases rest on a number of simplifying assumptions, which can now be discussed. First, in all cases above, the assumption was that farmers and economic analysts have full and correct information about the returns on conservation investments. Obviously, this is far from the true picture. Both farmers and agro-economic analysts need to learn from each other, and it should not be automatically assumed that the farmer is "ignorant" if he behaves in a non-predicted manner. Development "experts" have had to re-assess some of their advice in the face of evidence that traditional practices are more rational than they might appear at first sight. The approach that farmers are "poor but efficient" (Schultz, 1964) given the constraints at hand deserves to be revived from time to time.

Second, the assumption was made that all households could be averaged to a "representative" one, whereas real households will differ. Conservation on field A may be financially attractive, while soil loss on the steeply sloping field B has already progressed so far that the standardized project measures are financially unviable. Thus, farming households will act differently, and to obtain a more realistic picture farmers should be grouped

according to crucial features such as access to land of various capability classes, labour and capital resources and so on.

Third, we have only considered a single project in isolation. If several projects are considered as competing alternatives, it is essential that also the ranking appears the same from a financial and economic perspective. Otherwise, some form of public intervention might be called for.

Fourth, we have so far ignored the cost of achieving corrections for distortions. There is a direct marginal cost for the administration of additional tax collection and subsidy payment. If an already existing scheme for both activities can be utilized, the marginal costs are likely to be small. However, there is also the excess burden due to the distortionary impact of the tax (Layard and Walters, 1978). This is a measure of the sum of consumer and producer surpluses lost, due to the introduction of the tax. Thus, the discrepancy between the financial and economic perspectives should only be corrected to the point where the marginal returns on the intervention are higher than its marginal cost. The mere existence of a distortion is not sufficient to warrant government intervention.

There is also the possibility that **policy reform** may turn out to be a more efficient means of promoting better land management, rather than selective intervention in relation to a project. This issue has been dealt with at length in chapters 2 and 3, and will not be repeated here.

Applications to Project Analysis

What policy messages about soil and water conservation projects have been brought forward in the studies reviewed? The general message is an optimistic one: the measures **under study** have been profitable. A counter-example is 16 (and to some extent 11), which reviews a large capital-intensive, top-down approach project in Malawi.

Differences in private and social profitability forms an interesting basis for discussion - as in 1, 5, 11, 16, 19

and 20. Most analysts think in terms of information, training and subsidies, but taxes on soil loss is an idea also put forth, as well as the idea of more closely targeted intervention. Leaving a few studies behind, where this discussion is not well developed, it is interesting to compare the categories discussed above with their treatment in the empirical literature.

Abelson (1979) notes that the net benefits to landowners were higher than the social benefits and so significant that public intervention may be questioned. The justification, it is argued, behind the public expenditure is that it provided technology that the farmers otherwise would have adapted only slowly. It appears that investment in information should have been enough to speed up the process.

Anderson (1987) does not explicitly calculate the financial returns, only the economic. They are found to be strongly positive (15-19 percent) for both shelterbelts and farm forestry. As farmers are assumed to bear only a smaller portion of the costs for farm forestry it appears that financial return would be very high. If that is so, how come farmers do not capture these high returns already? The answer probably lies in institutional factors such as land tenure and quality of extension service and distribution services that seem to lie behind previous failures to achieve large scale tree planting in Nigeria. These issues are given little attention, but may undermine the technical assumptions of the CBA. Anderson argues in favour of public investment and support including research on soil fertility changes, technology packages and farmer responses to soil and water conservation projects, which can be seen as a means of improving the capability to accurately predict values of NPVf/e. He also suggests a more distinct focus on a limited area, rather than aiming at immediate regional coverage of this type of a program.

Christophersen and Karch (1988) are very clear in their contrasting of financial and economic results. As they compare a multitude of project types, falling into several of the categories identified above, the overall result is not easily summarized in a few lines. One general conclusion is that most of the potential conservation measures are financially (and economically)

attractive even at a private discount rate of 20 percent (cf. category IV in table 4.4). The recommendations include public support for monitoring and evaluation and study trips for key farmers and extension agents. This amounts to "investment in information" where the case for public intervention can easily be made.

On one point the advice goes against the result of their own economic calculations; the NPV of the contour ridges falls in category I. Yet, the authors argue that one should continue to emphasize this measure. Apparently, the authors themselves feel that the financial and economic analyses have not adequately captured all aspects. This may be true, but unless the basis for additional considerations is well specified, such ad-hoc adjustments are unfortunate. If the (undeclared) position is taken that **all** land rehabilitation measures are worthwhile, regardless of financial and economic cost, there is no point in carrying out a CBA.

Harris (1982) discusses why farmers should be subsidized when they reap the benefits of conservation projects themselves. He argues that there are positive intangibles such as soil and water conservation "per se", improvement of water quality and recreational benefits from destocked rangeland. Furthermore, the private IRRs for conservation investments, although positive, are lower than the interest on bank saving in New Zealand. Harris proposes a flexible cost sharing scheme where the government share of the cost of conservation would be 100 percent for financial return less than 10 percent and to decrease linearly to zero at a financial IRR of 25 percent.

Public, positive externalities would constitute a case for subsidies to range conservation, whereas a lower financial IRR to conservation than the bank savings rate in itself should not. Furthermore, it appears that Harris has not considered any cost for public funds. There would also be a disincentive to economize when undertaking conservation measures: for a project with a low return, there would be no financial cost at all for the farmer.

Three more studies pay brief attention to policy implications. Mwakalagho (1983) finds the large-scale mechanized soil conservation project in Malawi under study to be economically inefficient and financially

barely efficient, (category III). He does not enter into a discussion about public policy, but suggests a reorientation of project content from structural to biological measures. Veloz et al (1985), with results in category IV, argue that subsidies are necessary to equalize the financial returns to the social in parts of the studied watershed in the Dominican Republic. Similarly, Wiggins (1989) notes that protection of steep slopes is considerably more profitable economically than financially due to the strong external siltation effects, calling for public intervention.

The important role of macroeconomic policy as a backdrop for conservation efforts is clearly pointed out in some studies. Christophersen and Karch (1988) note that mini tree nurseries in Mali, although needed as an alternative to inefficient central nurseries, are not financially feasible due to the low government fixed price for seedlings.

With an example from the USA, Lockeretz (1981) points to the inconsistency in public policy when it wants to both encourage the soil conservation and the use of renewable fuels such as crop residues: "On one hand, subsidies for renewable energy will increase the price of crop residues, in turn increasing the quantity sold and consequently the loss of soil. On the other hand, soil conservation programs will then have to offer farmers more to get them to choose soil-conserving methods." (Ibid., p. 87).

Veloz et al (1985) bring in further elements of public policy in the Dominican Republic that have a bearing on the adoption of conservation measures: (a) inadequate agricultural extension service, (b) limited security in tenure, (c) difficulties in obtaining credit due to public interest rate control leading to credit rationing, (d) the persistence of open-access grazing land and (e) the overvaluation of the domestic currency, which disfavours growing of export crops in environmentally beneficial agroforestry schemes.

Wiggins (1980), with an example from El Salvador, calls for public intervention in terms of extension, incentives and enforcement of the existing Land Rental Law which provides for a minimum three-year rental contract.

Without this security, tenants are unlikely to be interested in conservation.

In summary, some of the reviewed studies have placed their project into a more comprehensive framework of macroeconomic policies affecting land utilization. There is a tendency to regard public intervention as an item without cost. Sometimes, the differences between financial and economic returns are not discussed at all, and the question of why farming households do not (or could not in the future) capture substantial financial returns on their own initiative receives little attention.

4.12 Summary and Conclusions

This chapter initially discusses the rationale for public intervention through specific land rehabilitation projects. It is argued that even after a **realistic** degree of general policy reform to improve land management, there is a role for specific projects in order to combat land degradation. The project type of efforts are also likely to continue for institutional reasons. As the resources of governments and aid agencies will always be limited, they will have to be carefully directed in concerted efforts to specific target areas. These efforts should include a component of financial and economic monitoring, in order to ensure efficient resource use. This is where project level cost-benefit analysis has a vital role to play.

The **purpose** of this chapter is to review the theory of CBA and its application in empirical analyses of land improvement projects. This provides a foundation for the case study from Lesotho presented in chapter 5. This chapter does not derive new theory pertaining to cost-benefit analysis. While there are already many reviews of cost-benefit theory, the format here is intended to bring out the dual picture of theory and application in a particular field that has been the subject of very limited attention among economists. We are not aware of any similar review pertaining to the field of soil and water conservation. The chapter is organized in nine themes pertaining to CBA, and surveys 20 applied studies of soil and water conservation projects.

The use of **evaluation criteria** for project worth is centered around the Net Present Value and derived measures such as the economic Internal Rate of Return and Benefit-Cost Ratio. These are generally used in applied studies, with a few exceptions referring more or less strongly to pay-back periods. The latter may result in misleading advice, and care must be exercised also with the use of IRR and BCR in project selection. Conflicting ranking according to multiple criteria is not always clearly resolved.

Income distribution has been given considerable attention in the academic literature on CBA. One would expect this theme to be of major concern in developing countries. It

is therefore a discouraging finding that so little is done empirically in trying to evaluate the distributional impacts of land rehabilitation projects. Empirical difficulties of data gathering are an important constraint, but decision-makers need to be alerted to the distributional impact of land management projects.

Identification of costs and benefits present few theoretical problems, but may cause difficulties when delineating the area of analysis in practice. Identification has been done in a conceptually sound way in the studies surveyed, with a few minor exceptions. Benefit identification is largely confined to the immediate project area, with few studies considering indirect environmental impacts and secondary effects on the community at large.

Regarding the assessment of **quantitative** variables, the review on this point underlines the need for substantial research on erosion-productivity relationships. A few advanced, general models are available, but are poorly suited for the developing country context because of high demands on quality data and skilled personnel. Even simple empirical research on erosion-yield relationships is rare in developing countries. This is reflected in the reviewed studies, which exhibit a range of approaches using farmer interviews, external literature sources, informal expert advice and local crop samples and experiments. The quality or relevance of these sources is often obscure or doubtful.

A concerted, interdisciplinary effort must be made to generate such data as is relevant for developing country circumstances, and to develop methods for their application which are consistent with the constrained resources available. An important factor is the integration of physical field data into economically meaningful relationships. Erosion-yield experiments need not be extremely costly and could generate valuable data in only 5-10 years, as shown in Stocking (1986).

Valuation in economic prices is a principal raison d'être for CBA. The deviation between the financial (market) prices and economic prices reflecting willingness to pay can be considerable in highly regulated economies. In addition, externalities are, by definition, not priced in

financial terms. Empirically, this problem is solved by anything from careful and detailed reasoning to (more often) rather ad-hoc adjustments of wage rates and, sometimes, of the official exchange rate. Attention to changes in real prices over time is extremely limited. Valuation is commonly restricted to methods of estimating production impact.

A controversial subject is how future costs and benefits should be **discounted** to present values. This chapter reviews various options, but rejects the notion that particular environmental considerations should affect the choice of social discount rate. Such concerns can be more adequately addressed by other adjustments in the CBA. Applications to land rehabilitation projects reveal little or no theoretical preoccupation with the method of selecting a rate, and only passing references to its empirical basis. Nevertheless, there is an informal convergence around 10 percent, +/- 5 percent.

The choice of **time horizon** is not a theoretical problem, as in principle, an indefinite time horizon should be considered in order to encompass the full impact of a particular project. In practice, this is unnecessary, when project impacts are short-lived. The problem of setting a time horizon receives scant attention in applied studies. Usually, a period of 10-20 years is seen to be sufficient, and is simply postulated without further discussion. Given the common use of discount rates of the order of 10 percent, prolonged horizons may not greatly affect the results. However, to the extent that lower rates are justified, this is less valid.

Risk and uncertainty pose complex theoretical questions. Given uncertainties pertaining both to the project itself and external factors, the net present value is not a single number, but a set of values with probability distribution attached. Empirically, the answer to uncertainty is commonly sensitivity testing of major variables to illustrate how changes in assumptions alter values of evaluation criteria. The testing is commonly done by simple rules of thumb rather than by reference to probability estimates.

Finally, as for **policy conclusions**, the discussion in this chapter is confined to the interpretation of project

level cost-benefit analyses. A number of authors have pointed to the need to equalize the financial and economic returns through some form of public intervention. Some also argue in favour of subsidies to financially very attractive projects, without posing the question as to why private households are (or would be) unable to capture these opportunities themselves. The excess burden cost of public interventions is never discussed. This might reflect the fact that many land improvements are funded by foreign grants, taken as given from the recipient country perspective. Another theme that has been brought out is the importance of general (economic) policy for the adoption or rejection of conservation measures among farmers. This is a a major theme in chapters 2 and 3, but not further discussed here.

We have found a considerable gap between the sophistication of CBA theory and its application to soil and water conservation projects. A general impression is that applied studies often neglect to clearly specify the basis for crucial assumptions. Quantification of the production impact of conservation measures remains a troublesome aspect, requiring a concerted research effort. Distributional issues are generally disregarded. Theoretical references and discussions are virtually absent from most studies, making the procedure a rather mechanical one. However, the range of quality among empirical studies is considerable, and we have been able to learn from the best ones.

REFERENCES

Abelson, P., 1979: "Cost-benefit Analysis of a Soil Conservation-conservation Project", pp. 80-104 in Cost Benefit Analysis and Environment Problems.

Anderson, D., 1987: The Economics of Afforestation. A Case Study in Africa. The World Bank. Occasional Paper Number 1/New Series. Washington, D.C.

Antle, J.M., 1987: "Economic Estimation of Producers' Risk Attitudes", pp. 509-522 in American Journal of Agricultural Economics. Vol. 69. No. 3.

Arrow, K.J. and Fisher, A.C., 1974: "Environmental Preservation, Uncertainty, and Irreversibility", pp. 312-319 in Quarterly Journal of Economics. Vol. 88.

Arrow, K.J. and Lind R.C., 1970: "Uncertainty and the Evaluation of Public Investments Decisions", pp. 364-378 in American Economic Review. Vol. 60.

Bali, Y. P., 1977: "Application of Soil and Land Resources Inventory Data in Development Planning", pp. 303-312 in Journal of the Indian Society of Soil Science. Vol. 25. No. 3.

Binswanger, H.P., 1980: "Attitudes Toward Risk: Experimental Measurement In Rural India", pp. 395-407 in American Journal of Agricultural Economics. Vol. 62. No. 1.

Binswanger, H.P., 1982: "Empirical Estimation and Use of Risk Preferences: Discussion", pp. 391-393 in American Journal of Agricultural Economics. Vol. 64. No. 2.

Birgegård, L-E., 1975: The Project Selection Process in Developing Countries. A Study on the Public Investment Project Selection Process in Kenya, Zambia and Tanzania. EFI, The Stockholm School of Economics, Stockholm.

Bishop, R., 1982: "Option Value: An Exposition and Extension", pp. 1-15 in Land Economics. Vol. 58.

Bohm, P., 1975: "Option Demand and Consumer's Surplus: Com-ment", pp. 733-736 in American Economic Review. Vol. 65. No. 4.

Bojö, J., 1986a: A Review of Cost-benefit Studies of Soil and Water Conservation Project. Report No. 3 from the SADCC Coordination Unit for Soil and Water Conservation and Land Utilization. Maseru, Lesotho.

Bojö, J., 1986b: An Introduction to Cost-benefit Analysis of Soil and Water Conservation Projects. Report No. 6 from the SADCC Coordination Unit, Maseru, Lesotho.

Bojö, J., Mäler, K-G. and Unemo, L, 1990: Environment and Development: An Economic Approach. Kluwer Academic Publishers. Dordrecht, The Netherlands.

Brooks, K. N., Gregersen, H. M., Berglund, E. R., and Tayaa, M., 1982: "Economic Evaluation of Watershed Projects - an Overview Methodology and Application", pp. 245-250 in Water Resources Bulletin. Vol. 18. No. 2.

Brown, S.P.A., 1983: "A Note on Environmental Risk and the Rate of Discount", pp.282-286 in Journal of Environmental Economics and Management. Vol. 10.

Buchanan, J.M. and Stubblebine, W.C., 1962: "Externality", pp. 371-384, in Economica. Vol. 29.

Christophersen, K.A. and Karch, G.E., 1988: Financial and Economic Analyses of Reforestation, Soil Conservation and Improved Woodstove Activities: Village Reforestation Project. Energy Initiatives for Africa. Washington, D.C.

Cicchetti, C.J. and Freeman, A.M., 1971: "Option Demand and Consumer Surplus: A Further Comment", pp. 528-539 in Quarterly Journal of Economics. Vol. 85.

Coase, R.H., 1960: "The Problem of Social Cost", pp. 1-44 in Journal of Law and Economics. Vol. 3.

Cook, K., 1982, "Soil Loss: A Question of Values", pp. 89-92 in Journal of Soil and Water Conservation. Vol. 37.

Cooper, C., 1981: Economic Evaluation and the Environment. Hodder and Stoughton. London.

Das, D. C. and Singh, S., 1980: "Small Storage Works for Erosion Control and Catchment Improvement: Mini Case Studies", in Morgan, R. P. C. (ed.). Soil Conservation: Problems and Prospects. J. Wiley, Chichester, England.

Dasgupta, P., Marglin, S. and Sen, A., 1972: Guidelines for Project Evaluation. UNIDO. United Nations, New York.

Dillon, J.L. and Scandizzo, P.L., 1978: "Risk Attitudes of Subsistence Farmers in Northeast Brazil: A Sampling Approach", pp. 425-435 in American Journal of Agricultural Economics. Vol. 60. No. 3.

Drèze J. and Stern, N., 1987: "The Theory of Cost-Benefit Analysis", pp. 909-989 in Auerbach, A.J. and Feldstein, M. (eds.), Handbook of Public Economics. Vol. 2. Elsevier Science Publishers B.V. North Holland.

Figueroa, J. F. R. and Garduno, M. A., 1980. "Evaluacion de Cinco Tipos de Terrazas en Suelos de Ladera de la Cuenca del Rio Tezcoco" (Evaluation of Five Terracing Methods in Soils of the Slopes of the River Tezcoco Basin), pp. 129-144 in Agrociencia, No. 41. Mexico.

Fisher, A.C., 1973: "Environmental Externalities and the Arrow-Lind Public Investment Theorem", in American Economic Review.

Fisher, A.C., 1981: Resource and Environmental Economics. Cambridge University Press. Cambridge.

Freeman, A.M. III, 1984: "The Sign and Size of Option Value", pp. 1-13 in Land Economics. Vol 60. No. 1.

Gauchon, M. J. (ed.), 1976: Some Economic Aspects of Watershed Management. Upper Solo Watershed Management and Upland Development, Indonesia. FAO. UNDP/SF/INS/72/006. Field termination report no. 7.

Gauchon, M. J. and Lok, S. H., 1973: Methodology for Economic Evaluation of Comprehensive Watershed Management. Upland Development and Watershed Management Project, Korea. FAO, Seoul. AGL/ROK/67/522. W.P. 1.

Gittinger, J.P., 1982: Economic Analysis of Agricultural Projects. 2nd ed. Johns Hopkins University Press. Baltimore & London.

Gupta, S. B. L., Prasad, R. and Pandey, R. K., 1973. "An Economic Evaluation of Soil Conservation Measures in Varanasi District, U.P.", pp. 205-211 in Indian Journal of Agricultural Economics. Vol. 28. No. 4.

Harberger, A.C. 1971: "Three Basic Postulates for Applied Welfare Economics - an Interpretative Essay", pp. 785-797 in Journal of Economic Literature.

Hardin, G., 1968: "The Tragedy of the Commons" in Science, Vol. 162, 13 December. Reprinted in Hardin, G. and Baden, J. (eds.), 1977: Managing the Commons. W.H. Freeman & Co. San Francisco.

Hardin, G. and Baden, J., 1977: Managing the Commons. Freeman & Co. San Francisco.

Harris, G., 1982: The Economics of Soil Conservation in the Otago High Country. Research Report no. 125, Lincoln College, Agricultural Economics Research Unit, New Zealand.

Hedfors, L., 1981: Evaluation and Economic Appraisal of Soil Conservation in a Pilot Area. Ministry of Agriculture, Soil & Water Conservation Branch, Nairobi, Kenya.

Helmers, F.L.C.H., 1979: Project Planning and Income Distribution. Martinus Nijhoff Publishing. Boston, The Hague and London.

Henry, C., 1974: "Option Values in the Economics of Irreplaceable Assets", pp. 89-104 in Review of Economic Studies.

Holmberg, G., 1985: Evaluation and Economic Appraisal of Soil Conservation in Kalia Sub-location - Kitui District. Ministry of Agriculture, Soil & Water Conservation Branch. Nairobi, Kenya.

Hudson, N., 1986: Soil Conservation. B.T. Batsford Ltd. London.

Irvin, G., 1978: Modern Cost-Benefit Methods. An Introduction to Financial, Economic and Social Appraisal of Development Projects. Macmillan. London and Basingstoke.

Kislova, T. A., 1979. Ekonomicheskaya otsenka protivoeozionnykh lesonasazdenii, sozdannyk po beregu r. Dnestra. (Economic Evaluation of the Anti-erosion Stands Established Along the Bank of the River Dnestra), pp. 7-10 in Lesnoe Khozaistvo No. 12.

Krutilla, J.V., 1967: "Conservation Reconsidered", in American Economic Review. Vol. 57.

Layard, P.R.G. and Walters, A.A., 1976: "The Date of Discounting in Cost-Benefit Studies", pp. 263-266 in Journal of Transport Economics and Policy. Vol. 10.

Lind, R.C., 1982: Discounting for Time and Risk in Energy Policy. RFF. Johns Hopkins University Press. Baltimore and London.

Little, I.M.D. and Mirrlees, J.A., 1974: Project Appraisal and Planning for Developing Countries. Heinemann. London.

Lockeretz, W., 1981. "Crop Residues for Energy: Comparative Costs and Benefits for the Farmer, the Energy Facility, and the Public", pp. 71-89 in Energy in Agriculture. No. 1 1981/82. Elsevier Scientific Publishing Company. Amsterdam, The Netherlands.

Mäler, K-G-, 1985: "Welfare Economics and the Environment", pp. 3-60 in Kneese, A.V. and Sweeney, J.L. (eds.), Handbook of Natural Resource and Energy Economics. Vol. 1. Elsevier Science Publishers B.V. North Holland.

Markandya, A. and Pearce, D., 1988: Environmental Considerations and the Choice of the Discount Rate in Developing Countries. Environment Department Working Paper No. 3. World Bank. Washington, D.C.

McKean, R.N., 1958: Efficiency in Government Through Systems Analysis. With Emphasis on Water Resources Development. John Wiley & Sons, Inc. New York.

Miranda, M.L., 1990: Essays on Land Management. A thesis presented to the Department of Economics. Harvard University, Cambridge, MA.

Mishan, E.J., 1982: Cost-Benefit Analysis. Third edition. Allen & Unwin. London.

Mitchell, R.C. and Carson, R.T., 1989: Using Surveys to Value Public Goods. The Contingent Valuation Method. Resources for the Future. Washington, D.C.

Mwakalagho, R., 1983. A Critical Appraisal of Physical Soil Conservation in the Lilongwe Rural Development Project. M.Sc. Thesis. University of East Anglia. Norwich.

Narayanan, A. S., Lee, M. T., Guntermann, K., Seitz, W. D. and Swanson, E. R., 1974: Economic Analysis of Erosion and Sedimentation. Mendota West Fork Watershed. Department of Agricultural Economics. Agricultural Experiment Station, University of Illinois at Urbana-Champaign.

Nobe, K.C., and Seckler, D. W., 1979: An Economic and Policy Analysis of Soil-Water Problems in the Kingdom of Lesotho. LASA Report no. 3. Ministry of Agriculture and Department of Economics, Colorado State University.

OECD, 1989: Environmental Policy Benefits: Monetary Evaluation. OECD. Paris.

Pearce, D. and Nash, C.A., 1981: The Social Appraisal of Projects. A Text in CBA. Macmillan.

Pigou, A.C., 1920: The Economics of Welfare. Macmillan. London.

Price, C., 1973: "To the Future: with Indifference or Concern? - The Social Discount Rate and its Implications in Land Use", pp. 393-398 in Journal of Agricultural Economics. Vol. 24. No. 2.

Prince, R., 1985: "A Note on Environmental Risk and the Rate of Discount: Comment", pp. 179-180 in Journal of Environmental Economics and Management. Vol. 12.

Randall, A., 1983: "The Problem of Market Failure", pp. 131-148 in Natural Resources Journal. Vol. 23. No. 1.

Reiling, S.D. and Anderson, M.W., 1980: The Relevance of Option Value in Benefit-Cost Analysis. Life Sciences and Agriculture Experiment Station. University of Maine at Orono. Technical Bulletin 101.

Schertz, D.L., 1983: "The Basis for Soil Loss Tolerances", pp. 11-14 in Journal of Soil and Water Conservation. Vol. 38. No. 1.

Schmalensee, R., 1972: "Option Demand and Consumer's Surplus: Valuing Price Changes under Uncertainty", pp. 813-824 in American Economic Review. Vol. 62. No. 5.

Smith, V.K., 1984: Intrinsic Values in Benefit Cost Analysis: New Research Frontier or License for Abuse. Working Paper No. 84-W19. Vanderbilt University. Nashville Tennessee.

Squire, L. and van der Tak, H.G., 1975: Economic Analysis of Projects. World Bank and Johns Hopkins University Press. Baltimore and London.

Smith, V.K., 1986: "A Conceptual Overview of the Foundations of Benefit-Cost Analysis", pp. 13-34 in Bentkover, J.D., Covello, V.T. and Mumpower, J. (eds.), Benefit Assessment. The State of Art. D. Reidel Publishing Company. Dordrecht.

Stocking, M., 1986: The Impact of Soil Erosion in Southern Africa: A Research Design for Assessing Physical and Economic Losses in Soil Productivity. Report No. 2 from the SADCC Coordination Unit, Maseru, Lesotho.

Stocking, M. and Peake, L., 1985: Erosion-Induced Loss in Soil Productivity: Trends in Research and International Cooperation. Paper to the IV International Conference on Soil Conservation, Maracay, Venezuela. FAO & Overseas Development Group, University of East Anglia. Norwich.

Stocking, M. and Abel, N., 1989: Labour Costs: A Critical Element in Soil Conservation. Paper to the 6th International Soil Conservation Conference. Addis Abeba, Ethiopia. University of East Anglia. Norwich.

Veloz, A., Southgate, D., Hitzhusen, F. and Macgregor R., 1985: "The Economics of Erosion Control in a Subtropical Watershed: A Dominican Case", in Land Economics. Vol. 61. No. 2.

Weisbrod, B.A., 1964: "Collective-consumption Services of Individual-consumption Goods, Quarterly Journal of Economics. Vol. 78. No. 3.

Weisbrod, B.A., 1968: "Income Redistribution Effects and Benefit-Cost Analysis", pp. 177-209 in Chase Jr, R.B. (ed.), Problems in Public Expenditure Analysis. The Brookings Institution. Reprinted in Layard R. (ed.), 1974: Cost-benefit Analysis. Penguin Books Ltd. Hammondsworth, Middlesex, England.

Wiggins, S. L., 1980: "The Economics of Soil Conservation in the Acelhuate River Basin, El Salvador", in Morgan, R. P. C. (ed.), Soil Conservation: Problems and Prospects. John Wiley. Chichester, England.

Williams, J.R, Jones, C.A. and Dyke, P.T., 1984: "A Modeling Approach to Determining the Relationship Between Erosion and Soil Productivity", pp. 129-144 in Transactions of the ASAE. Vol 27. No. 1. American Society of Agricultural Engineers. St. Joseph, Michigan.

Willig, R.D., 1976: "Consumer's Surplus Without Apology", in American Economic Review. Vol. 66. No. 4.

Wischmeier, W.H., 1976: "Use and Misuse of the Universal Soil Loss Equation", pp. 5-9 in Journal of Soil and Water Conservation.

Wischmeier, W.H. and Smith, D.D., 1978: Predicting Rainfall Erosion Losses. United States Department of Agriculture, Agricultural Handbook 537.

5. COST-BENEFIT ANALYSIS OF LAND IMPROVEMENT PROJECTS: A CASE STUDY FROM LESOTHO

5.1 Background

In the previous chapter, an overview was given of how the theory of cost-benefit analysis has been applied to the specific field of land degradation projects. This chapter builds on both the theoretical considerations and the empirical experience reflected in chapter 4, and presents research carried out by the author in Lesotho. The analysis focuses on data from the Farm Improvement with Soil Conservation (FISC) project area in Mohale's Hoek District, Lesotho. Previous work on economic evaluation of this project can be found in Bojö (1989a, 1990a, 1990b).

The Private versus the Social Perspective

The analysis is carried out with several different perspectives in mind. Firstly, there is the **farming household perspective**. This is dealt with under the heading of **financial** analysis. Secondly, there is the **economic** perspective. This is relevant[1] for the **Government** of **Lesotho** (GoL) and the **donor organization**: the Swedish International Development Authority (SIDA). The allocation of resources to SIDA by the Government of Sweden will be taken as given by a political commitment to uphold a certain level of aid funding. This implies that the discussion of the excess burden involved in financing foreign aid through taxation, as well as

1. The claim that the economic perspective is **relevant** is far from the statement that this is the **only** perspective considered by these actors. On the contrary, other aspects are important.

comparisons between aid and alternative investments in Sweden, can be left aside.

The perspectives of GoL and SIDA share common features, but they can also differ on several accounts. In conformity with chapter 4, differences regarding the following points will be briefly considered: evaluation criteria, identification, quantification and valuation of costs and benefits, discounting, time horizon, risk and income distribution.

1. The **evaluation criteria** applied will vary depending on the perspective applied. There are several schools of thought concerning the objectives of the peasant household (Ellis, 1988). The peasant is sometimes assumed to maximize profit, to minimize risk, to minimize drudgery and so on. These aspects can be reconciled. It will be assumed that farmers in Lesotho are concerned with maximizing utility, and that this entails the maximization of net revenue, incorporating the cost of drudgery as a part of the calculation. In addition, the consideration of the lower part of the probability distribution of net profits is particularly important for those who receive little or no migrant remittances. Thus, both the expected value of net revenue and its distribution will affect farmers' decision-making.

The Government of Lesotho (GoL) has an official set of goals with its development policy, as summarized in its current Five-Year Development Plan. The overriding strategic objective is phrased as: "accelerated development with a view to meeting more adequately basic needs and achieving a more equitable distribution of national wealth." Closely associated objectives are the "maximization of national income and employment". (MoP, 1987, p. 839). The list of well-intended goals is long, but the internal priorities are not very clear. The particular policies for livestock and crop production have been discussed in chapter 3, and will not be repeated here.

The donor organization's general goals for giving aid are: economic growth, economic and social equity, democracy and economic and political independence (SIDA, 1987a). In 1988, the Swedish Parliament added the goal of promoting sustainable use of natural resources and

environmental protection to the previous list.[2] Unofficially, there is also a "disbursement goal" (RRV, 1988), i.e. a desire to spend the money allocated to the country in question. In the case of Lesotho, this has been difficult at times. Although economic growth is only one out of five official goals, the others are not unrelated to the use of cost-benefit analysis.

First, the equity goal can be addressed as an integral part as discussed in chapters 4 and 5. Second, democratic decision-making is strongly related to public participation in project activities, especially in the long-run, when the force of coercion has generally proven to be ineffective. The degree of popular participation will be reflected also in the economic performance of a project. Third, the goal of independence can be given an operational meaning such that a conservation project is successful if it raises the domestic production at the expense of imports. Again, this coincides with the CBA focus on increased output. Fourth, the goal of sustainability can be operationalized to mean that the project must be successful in conserving the land for future production. This is consistent with the CBA approach, which will credit the project for differences in production due to soil and nutrient retention. So much for the general goals; we will return to the SIDA project specific goals below.

2. The **identification** of costs and benefits is another item that separates the financial and the economic perspectives. Interviews with peasants in Lesotho have shown that land degradation ranks rather low as a concern of the rural household (Gay, 1984; Mashinini, 1988; Wilken, 1982). This is in strong contrast with the alarming accounts of erosion in Lesotho that foreign and domestic experts have offered (Chakela et al, 1989; Grainger, 1990; Pim, 1935; Schmitz and Rooyani, 1987).

As there are economies of scale in the production of information, social organizations can assemble and generate information on a much more advanced level than individuals. The results are not often well communicated down to the grass roots level. This may e.g. concern erosion processes and impacts on crop yield. On the other

2. See SOU 1987:28 for a background and elaboration of this goal.

hand, the individual peasant knows his/her own surroundings and conditions in greater detail than any outsider. The role of erosion may be somewhat better perceived on a general level by the government and a donor organization, than by a farmer who observes a stochastic yield with some determining factors that are much more apparent than the slow, treacherous erosion process: drought, hail, pests and so on. However, the mere identification is not very helpful unless we can quantify the relationship between soil loss and production.

Some cost/benefit items are not individually captured because property rights are non-existent or communal. Degradation of communal grazing land does not impact non-livestock owning households directly. Revenue from a communal fuelwood plantation or garden may be controlled by a local élite and its division skewed. Fears of being cheated on communal benefits are common in the project area (Dahlberg, 1987).

3. With different sets of information available, the **quantification** of costs and benefit items will differ. The government and the donor can institute monitoring systems that collect quantitative data. Even so, substantial difficulties will remain in arriving at good estimates that can be used for economic and financial analysis. This has already been discussed in chapter 3. If centrally gathered information is not effectively disseminated to farming households, quantification will differ between perspectives. A concrete example is the perception of crop yield impact of various farm management options. While government actively promotes the use of fertilizer and hybrid seed with donor support, farmer response remains reluctant in many cases.

4. The **valuation** of costs and benefits is another point where perspectives may differ. Farming households will use financial (market) prices in their calculations. They may be expressed in monetary terms directly, or indirectly by valuing in-kind payments. However, the economic perspective should consider economic prices based on consumers' willingness to pay.

5. The **discount rate** applied will depend on what perspective is applied. The household will consider

investments in soil and water conservation and other farm improvements as opposed to competing opportunities. Their private discount rate will depend on the preference for consumption now versus the future and the yield on alternative investments. With low incomes, the desire for immediate consumption is generally high. The options under consideration by the government and the donor organization are, of course, entirely different. This yields a different opportunity rate of discount.

6. The private household is commonly assumed to apply a very short **time horizon** to its investment decisions: the poorer the household, the more immediate the concerns about quick returns. This would not matter if markets were perfect: Any future value resulting from an investment today would be capitalized in a higher market price today. Similarly, any investment yielding more than the cost of borrowing could be funded on the capital market. In reality, markets for land and investments in improvements of land are quite restrained in Lesotho, as shown in chapter 3.

Governments and donor organizations can afford to take a long-term view. How long it is will depend on the need for governments to gain political, short-term support in e.g. elections. This is not likely to be a major immediate consideration for the government in Lesotho, for reasons explained in chapter 3. However, a future Lesotho with a democratically elected leadership might act in a more tactically determined fashion. For SIDA, there is little need to demonstrate short-term impacts in order to defend the financial scope for action. Total Swedish aid appropriations are an automatic 1 percent of Gross National Income, and annual opinion polls show a continued high rate of support for Swedish aid to developing countries.[3]

7. The single household is often quite vulnerable to **risk**. Therefore, maximization of profit may be restrained by a strong concern for risk-avoidance, and the probability distribution of net revenues around the mean

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3. Two recent opinion polls (SIDA, 1990, 1991) indicate that the public support for the overall aid level may be decreasing. If the tendency continues, this may force SIDA to become more concerned about the efficiency of aid.

may be crucial for the acceptance/rejection of a new management scheme. Society at large, and donors, can rely on risk spreading (the costs are borne by a large collective, each individual paying little) and risk pooling (some projects work well, others fail, but they balance out).

8. The farmer can be expected to be primarily concerned about his own and his own family's welfare. It is the official goal of the GoL and in the mandate of the donor organization to consider income distribution aspects of their work. Therefore, the weight attached to costs and benefits will vary between the perspectives.

On the basis of this list of eight considerations, it can be seen that the **financial** perspective and the **economic** perspective(s) require separate analyses.

The remainder of the chapter is organized as follows. This section goes on to give a brief presentation of the activity under study: The Farm Improvement with Soil Conservation (FISC) Project. The financial analysis is the subject of section 5.2. The major portion of the chapter, section 5.3, is devoted to the economic cost-benefit perspective on the project. Finally, section 5.4 summarizes and discusses conclusions.

Choice of Project for the Study

The choice of the FISC project as an object of study is determined by two important considerations. The first is its **approach to soil conservation:** It is a project in line with the "new" philosophy regarding soil and water conservation, discussed in chapter 2:

a) it is production (rather than preservation) oriented;
b) it uses labour intensive technology;
c) it builds on popular participation.

While warning against wide generalizations from this particular study, one may at least make the claim that it is one interesting observation of how this "new" approach has stood the test in real life.

Furthermore, leading political authorities in Lesotho, including the King and the Minister of Agriculture[4] have praised this project as a model for the country (Lesotho Today, 5 Nov. 1986). Several other soil conservation projects have used FISC as a model. As of early 1991, FISC has gained more and more of the stature as a national model for farm improvement and soil conservation programmes in Lesotho. This underlines the importance of making a thorough assessment of FISC before further replication is attempted.

The second important consideration in the choice of project is simply **accessibility**. Data gathering is only possible with the active cooperation of the project staff. Project staff has been very keen to cooperate in this research. The executing company, Swedforest Consulting AB, has been willing to share internal documents with the author. The analysis has evolved over the years in a dialogue with project management and others concerned.

The FISC Project

The current project area is located in Mohale's Hoek District in the south of Lesotho. The climate is warm temperate, sub-humid with an average annual temperature of 16° C and an average annual precipitation of 720 mm. The land use in the area is primarily cultivation and grazing. The pressure on the land is very high and even clearly unsuitable land is cultivated. This makes the area rather typical for the Lowland region in the southern part of the country.[5]

How representative is the project area for the rest of Lesotho? Soil losses, as calculated by the Universal Soil Loss Equation (USLE) are given in table 3.7 in chapter 3, and show the rate for Mohale's Hoek District to be about average for Lesotho. However, gully erosion should be added, and is among the most severe in Mohale's Hoek District. Still, the extent and rate of erosion appears to well represent Lowland circumstances in Lesotho. Maize

4. Both individuals have since been replaced, but there is no sign that the political importance attached to the project has diminished. On the contrary, it seems to have increased.
5. A more general introduction to Lesotho and its regions is contained in chapter 3.

yields are commonly below the national average, while sorghum yields are as often higher than, as lower than, the national average (BoS, 1986). Prices at Co-op Lesotho depots, supplying agricultural inputs and buying outputs, are the same in all Lesotho. Local output prices are somewhat higher in inaccessible mountain areas. In conclusion, the area is fairly representative of conditions in the Lowlands, the area that dominates crop production and where most of the people live. With some adjustments, the calculations could be used to simulate Foothills and Mountain conditions.

The history of the Farm Improvement with Soil Conservation project goes back to 1981, when consultant studies were initiated by the Swedish International Development Authority (CPDO, 1982; Palin, 1983; Wenner, 1982). The project was launched in 1985. FISC was intended to be the beginning of a nationwide effort to combat soil erosion. As such, it has attracted more attention than its current size would seem to justify.

The FISC project is funded by SIDA, but there is also close cooperation with regular district staff in the joint efforts. The overriding aim of the project is (SIDA, 1983) to **raise production** by:

- organizing soil conservation work through the regular extension service;

- introducing new methods for soil conservation with labour intensive techniques;

- elaborating guidelines for the productive use of conservation structures (fodder, fruit trees and other bushes and trees);

- demonstrating through field activity the role of soil conservation as a production augmenting factor in agricultural production;

- reaching 2 300 farms over a three-year period with soil conservation measures, subsidized inputs and tree seedlings.

To "raise agricultural production" is a very vague goal that does not lend itself easily to evaluation. Increased

agricultural production is to be expected when millions of dollars are spent, but the extent of the rise is the crucial issue. There are no quantitative indicators of performance given by the donor, except for the figure on the number of households that should be reached.

The project has rehabilitated old terrace structures, constructed new ones and added stone-paved waterways and cut-off drains. It has promoted hybrid maize and sorghum, encouraged the growing of fodder grasses, established a nursery and planted thousands of seedlings on the mountain slopes. It has also promoted rotational grazing on the higher mountainsides where uncontrolled use tends to devastate the rangeland.

Contributing to the attention given to the project is its use of labour-intensive and simple technical methods, and its emphasis on popular participation and consultation at all stages. Farmers working on physical conservation structures on their "own" land are given incentive payments in the form of hybrid seed, fertilizer or seedlings. People working on communal land are given cash payments. Recently, some communal efforts have been taken off the list as qualifying for payment as a result of discussions among farmer representatives: afforestation, spring development and gully reclamation are examples. The general ambition of the project, as well as of emerging local community leaders, is to decrease the payment of cash incentives for communal works. (FISC, 1991).

The project operates through the district agricultural office in the district capital, Mohale's Hoek. Thus, it is designed to support the government's general efforts in extending its conservation message to farmers. There is an important training component. Expatriates (originally one project manager/soil conservation engineer and one horticulturist) are supposed to have counterparts. This ambition has been only partially fulfilled. There are also considerable training activities targeted to extension agents, conservation assistants, conservation organizers, as well as "lead farmers" and other villagers. The project supports local decision-making structures such as the Village Development Councils (VDCs) in project areas. These are

supposed to shoulder the long term responsibility for maintaining conservation efforts.

The project was initiated in Maphutseng, Mohale's Hoek District. Gradually, FISC has been extended to include all extension areas in the same district, not already covered by other donor financed soil conservation projects. The number of recorded households is about 4400, making the total population in the project areas surveyed so far about 22 thousand. An overview of project areas is given in table 5.1. However, the activities in Braakfontein have been discontinued due to poor cooperation of village chiefs. The areas left unreported are new to the project and little activity is going on there at the time of writing.

Table 5.1 FISC Project Areas (Hectares)

Chieftain	Area	Cultivated	Range	Other
Mekaling	2818	1291	1273	254
Braakfontein (1)	1320	918	152	250
Braakfontein (2)	1967	1067	872	28
Ha Sekoati	1497	806	502	189
Maphutseng	1100	543	414	143
Ha Reentseng	4092	2120	1746	226
Ha Makhate	740	530	130	80
Tsoloane	3155	1477	727	951
Ha Monyake	1116	700	296	120
Siloe (1)	734	224	256	254
Siloe (2)	1866	1044	116	706
Ha Sephapho	1531	750	695	86
Ha Phala	1459	877	521	61
Draii Hoek	1848	936	824	88
Ha Tsepo	620	473	48	99
Ha Thaba Besou	NA	NA	NA	NA
Likoeneng	NA	NA	NA	NA
Ha Mahlehle	NA	NA	NA	NA
Total	25863	13756	8572	3535
Share of total (%)	100	53	33	14

Source: Adapted from FISC (1991).

Current project plans extend to mid-1992 (Swedforest, 1988). In addition, the previous Team Leader for FISC has taken up a position as national adviser on soil conservation in the Ministry of Agriculture, as of January 1991. The intention is to implant FISC methods in other areas.

5.2 Financial Analysis of the FISC Project

Does it pay for the farmer to follow the project recommendations? That is the essential question that this section sets out to discuss. This is also the question that FISC has to answer positively if it wants to retain the support of the local population.

The steps in the financial analysis coincide with the eight steps commented on in the first section. In terms of evaluation criteria, it is assumed here that farmers are concerned with maximizing net income, but also with avoiding risks. The benefit items identified to be of main interest from a household management perspective are output of maize, sorghum, fruits, fuelwood and fodder. Cost items identified are all financial input costs incurred by the farmers.

For maize and sorghum, quantification of output is done by looking at one hectare of land and its yield with vs. without the use of project recommended inputs. The alternatives will be referred to as "high input" and "traditional" management. Crop sampling has been undertaken as a part of this research to provide the necessary data. Quantification of costs and benefits is done per group of 10 trees for fruit and fuelwood trees, as the household generally has access only to very limited land around the homestead on which to plant these. Finally, the option of fodder cultivation is quantified using the work of Hahn (1990).

It needs to be pointed out that it should not be automatically assumed that all farmers using improved inputs do so because of the project. This underlines the importance of base-line data or control area data in order to isolate the net project impact. No base-line data were collected before the project was initiated in 1985, but comparisons can be made with non-project areas in the vicinity. More lately, Mashinini's (1988) study has given a base-line for some of the areas where the project is now active. To what extent project recommendations have in fact been adopted will be discussed below.

Valuation will be done using market prices. These are the prices relevant for household decision-making. In some

cases, they differ from economic prices, as discussed in section 5.3. As different households discount future costs and benefits with different rates, the financial internal rates of return will be calculated as a basis for a qualitative discussion. The time horizon is the expected length of productive life for fruit trees (20 years), the most profitable rotation period for pine fuelwood trees (12 years) and one of annual decisions of investment/non-investment in the use of advanced inputs for grain and fodder production. Income distribution aspects will be left out of the picture until it is time to consider the economic perspective. Policy conclusions will be discussed in terms of farmer incentives to participate in the project.

5.2.1 Crop Sampling Results 1986-90

A very substantial part of project activities concerns measures to increase crop yields in the area. In addition to the major effort of promoting soil conservation through mechanical conservation measures, the project recommends the use of 250 kg/ha of 2:3:2 N:P:K fertilizer and hybrid seeds: PNR 473 (maize) and PNR 8311 or G766W (sorghum).

Crop data have been collected in a joint effort by the author and the project for five years by means of random sampling from the project and control fields. The method for gathering data and the scope of this exercise has changed somewhat over the years as experience has accumulated. An important contribution was recently made in the work of Olofsson (1990). As details are given elsewhere, this text will only give a brief summary.[1]

Regardless of the exact sampling method used, the purpose has remained the same: to provide a basis for comparing the crop yields for a farmer with "high input" management (using fertilizer and/or hybrid seed commonly in addition to the soil conservation works) and one using "traditional" management (no fertilizer, local seed and no conservation works).

1. Details are given in Bojö et al. (1987), Bojö and Shone (1987, 1988), Bojö (1989c), Olofsson (1990) and Bojö and Shone (1991).

The method of sampling in 1990 was based on a sampling frame of a numbered list of farmers and their fields with identified crop management. A random sample of fields are drawn with the aid of a list of random numbers. To the extent that exact information is available on crop grown (not only management type), it is possible to pre-determine the selection of eight fields of maize and eight fields of sorghum, each divided in four fields "with" and four fields "without" high input management. If information about crops grown is not available, a sufficient number of fields are drawn and the actual crop grown is investigated in the field. In addition, demonstration fields, one with maize and one with sorghum, were sampled. These fields are established to demonstrate the impact of the use of project recommended inputs.

The exact area to sample in each field is determined by circumscribing the field with an imaginary quadrant and drawing random numbers, first for the longest side, then for the shortest. If a coordinate falls outside the often very irregular boundaries, a new number is taken from the table until it falls inside. For each field, at least two sampling points are determined. If the field is subjectively determined to have yield of an uneven character, up to five samples per field are taken.

Once the exact sampling point is determined, a special rotational device is utilized to harvest a crop area of exactly 10 m^2. The sample is put in labeled bags and taken to be threshed. The grain samples are weighed at short intervals to check that weight is stabilized. When the sample is considered dry, its weight is recorded.

In 1990, a survey was carried out to determine the quantity of fertilizer used per field and the type of seed planted, through interviews with all farmers concerned. As farmers do not know the size of their fields in terms of hectares, each field that had received fertilizer had to be measured.

The results for maize are summarized in the table below. As always in field research, the number of useful samples is less than the total number taken. This is due to inconsistencies in the data and the fact that some project areas lack a sufficient number of fields for each

category. In many cases, the fields that had been denoted as "high input" fields, were on later inspection described as being under "traditional" management by the farmer. There are several ways of analyzing the results. First, a simple table shows the size of the samples, mean yields for the two main categories and whether the measured difference is significant.

Table 5.2 Crop Sampling Results for Maize 1986-1990

Year	Area	n	Avg. yield kg/ha	Diff.signif. 5%
1986	High input	14	1 642	Yes
	Traditional	16	909	
1987	High input	14	329	No
	Traditional	12	222	
1988	High input	54	674	Yes
	Traditional	42	489	
1989	High input	38	887	Yes
	Traditional	32	337	
1990	High input	52	1837	Yes
	Traditional	59	1172	

Mean yields cannot be strictly compared across the years since the sampling procedure was changed somewhat over time. The discussion will not be repeated here[2]. However, the main point here is to compare the yield across management regimes during the same year. The table allows the calculation of the mean relative increase in maize yield: 77 percent. The reader is cautioned that:

(a) crop yield is a function of a number of intricately interwoven variables, not all of which can be controlled;

(b) the data from 1986 and 1987 build on small samples;

2. See Bojö and Shone (1991) for a summary.

(c) input use was poorly quantified prior to 1990.

Parallel sampling has been undertaken of the other major grain in the area, sorghum, as shown below.

Table 5.3 Crop Sampling Results for Sorghum 1986-1990

Year	Area	n	Avg. yield kg/ha	Significance 5%
1986	High input	15	2 052	Yes
	Traditional	15	1 057	
1987	High input	14	400	Yes
	Traditional	16	193	
1988	High input	52	732	Yes
	Traditional	56	513	
1989	High input	46	682	Yes
	Traditional	22	448	
1990	High input	35	1719	Yes
	Traditional	68	1214	

This table allows the calculation of the mean relative yield increase for sorghum over five years: 68 percent.

The additional efforts in 1990 to quantify input use makes it possible to conduct multiple regression in order to determine the impact of fertilizer and hybrid seed use on the micro level. The model estimated is simply:

$$Y_i = A + b * F_i + c * H_i + u$$

where

Y = yield of maize or sorghum in kg/ha
A = intercept
b,c = coefficients to be estimated
F = fertilizer use in kg/ha

H = dummy for use of hybrid seed
u = error term
i = field index

The results of the regressions are shown below.

Table 5.4 Grain Yield Regressions

Maize: $R^2 = 0.16$

Variable	Parameter Est.	Significance Level[3]
F	0.38	
H	730	***

Sorghum: $R^2 = 0.05$

Variable	Parameter Est.	Significance Level
F	0.37	
H	378	

Both regressions have weak explanatory power. This is not surprising, as they do not allow for the substantial local differences of soils, rainfall, field weeding, planting time, seed-bed preparation and so on. The only significant parameter is use of hybrid maize seed. In conclusion, this type of test has not been able to underpin the claim that investment in fertilizer and sorghum seed gives a significant impact on crop yield.

One possibility of overcoming the large local differences that detract from the explanatory power of cross-area regressions, are to "twin" samples locally. The fact that some farmers have used only fertilizer or only hybrid seed complicates the grouping. For maize, the few farmers not using both kinds of inputs were excluded. For sorghum, very few use hybrid seed at all, so the "high input" group consists almost completely of farmers using fertilizer only. The sampling procedure used does not

3. *** denotes significance on the 1 percent level, no entry denotes no significance at the 10 percent level.

allow individual matching of "twin" samples, but averages of grouped samples from each chieftainship could be taken. The result is shown below. The two last columns in the table show lower and upper boundaries for a 90 percent confidence interval relating to the difference between the yields.

Table 5.5 Differences between Locally Grouped Crop Samples

Crop	No pairs	Avg diff	Std dev	L.B.	H.B.
Maize	13	871	1036	- 838	2580
Sorghum	13	530	787	- 768	1828

Although the difference is substantial between management regimes, the precision in the estimate is low, due to the high standard deviation of the difference. The pairing clearly shows that some fields with "high input" management actually yield less in the same local area than fields with "traditional" management.[4]

Even with five years of crop sampling data, it is not possible to determine with precision what the impact of fertilizer and hybrid seed is. Exogenous factors will retain a determining influence and make such investments risky. Nevertheless, it is possible to make some illustrative financial calculations with reference to these data.

5.2.2 Financial Returns to Maize and Sorghum

The purpose here is to look at the impact of adopting the project's advice for the farmer. The gross margin (before labour cost) and net margin (after labour cost) per ha for an average farmer is calculated.

4. This is also the experience on a larger scale of the national Food Self-Sufficiency Programme, at least for particular years. See chapter 3.

This should not be misunderstood to read that the "high input" farmers have **exactly** followed the project's advice. There are clear indications that the use of fertilizer and hybrid seed has been less than that recommended among farmers that joined the project in terms of soil conservation. Few farmers use hybrid seed for sorghum, but fertilizer application in the "high input" management fields sampled in 1990 was roughly equal to project recommendations: 257 kg/ha. The figure was only 176 kg/ha for maize. This is a surprising result, as maize is often viewed as the crop receiving favoured treatment by Basotho farmers.

Financial Prices

The first items to consider are the prices of **crops.** The price to use in the financial calculation is the price the farmer can get, or the price he would have paid for the crops he has produced himself (replacement cost). District capital price data have been gathered from the Lesotho Coop Office in Mohale's Hoek. The selling price for the maize harvest in 1990, was M 34.41 for one bag (70 kg) of white maize and the corresponding price for sorghum was M 28.05.

To arrive at the local price, the cost of transportation to the project areas should be added. This will vary depending on how accessible the village is, but M 4-6 for a return bus fare will cover a substantial portion (Project staff, personal communication). Since such transports can be combined with other errands, the marginal cost for grain transportation will often be less. To allow for transportation effort and cash costs, the figure is rounded off to M 38 per bag (M 0.54 per kg) for maize and M 32 (M 0.46 per kg) for sorghum. Separate prices for the "high input and the "traditional" management situations are not considered, because the increase in crop yield is too small to influence the price substantially.

A secondary income item is **crop residues.** However, private access to these is insecure as crop land is still communally grazed. They are therefore left out of the base case financial calculation, but are discussed as an additional, separate item. The economic calculation will

include the full benefit of all increases in crop residue production, due to project activities.

The price of fertilizer in the autumn of 1989, used as input for the harvest in 1990, was M 30.83 for a bag (50 kg) of N:P:K 2:3:2 (Coop Lesotho, Mohale's Hoek Office). The project recommendation is to use 250 kg/ha, implying a cost of M 154.15 per ha if the recommendation is followed. Transportation is supplied by the project to local depots. In the future, Village Development Councils may be able to secure bulk delivery from Coop Lesotho without transportation charge. Therefore, no addition is made for this cost item in the financial calculation.[5]

FISC recommends certain hybrid seed varieties of maize and sorghum. The alternative is generally to save local seed. Very few farmers make any selection when setting aside seeds for use next season (Plath, 1982). In this case, the cost is the revenue lost (replacement cost incurred), so the local market price derived above is used to value this item. The seeding rate has been computed from data supplied by FISC management.

Table 5.6 Seed Cost 1989/90

	Maize		Sorghum	
	PNR 473	Local	PNR 8311	Local
M/10 kg	41.4	5.4	32.3	4.6
Kg/ha	15.0	15.0	10.0	10.0
M/ha	62.1	8.1	32.3	4.6

Sources: Coop Lesotho and FISC Team leader

Bags are used for the storage of grain. The cost of one (70 kg) jute bag was M 2.35 in 1990 (Coop Lesotho). Subjective estimates by independent project staff and villagers suggest that the life time of one bag is approximately three years. Assuming, that the farmer can

5. The costs for the project are incorporated in the economic calculation.

achieve a real rate of return of some 10 percent on alternative investment in e.g. cattle - see below - and that the rate of inflation remains about 15 percent (Central Bank, 1990), this gives an interest rate of 25 percent, which implies an annuity of about M 1.2 per year over 3 years.

The question of financial labour costs has two major components: what wage rate to apply, and the time spent working. Most farmers in Lesotho rely on their family labour for agricultural operations (Holland, 1983). However, there is still an opportunity cost due to foregone off-farm income opportunities, handicraft or home production such as child rearing, cooking, home improvements and so on. There is also the additional disutility of the hard work in the fields. While this is not necessarily a cash cost item, it is nevertheless a cost that the farmer will consider from his perspective, and it is therefore included in the analysis.

FISC pays M 3.5 since May 1988 for "one task". A task can usually be finished in one "day", corresponding to perhaps 4-6 hours of work. It is known that the informal labour market offers slightly lower wages, usually M 2.5 per "day" (project personnel, personal communication). The official minimum wage of M 6.99 has little significance in reality.

A few studies have been made concerning time usage in crop production in Lesotho. The results are summarized in the table below.

Table 5.7 Person-days/ha in Traditional Crop Production

Source	Maize	Sorghum
Plath (1982)	76	67
Holland & Ts'iu (1983)	77	89
IFAD (1986)	75	75
Average	76	77

Plath bases his estimates on records from 117 farmers representing the three physiographic areas in Lesotho. Holland and Ts'iu add another year's study of 119 farmers in the same areas. They are the only ones who specify their definition of "a working day": 4 hours. As this appears to be based on actual behaviour, this definition is accepted here. As their estimates are so close to the other sources, the same definition has probably been used there as well. Usually, no distinction is made between different sources of labour inputs. Thus, the result can be expressed in terms of "person-days". The source of IFAD's estimate is not given.

Obviously, the amount of necessary labour varies with (a) the kind of management used and (b) the actual output. Regarding the first aspect, the purchase of seed and fertilizer might require one additional day. The spreading of the fertilizer could be done by hand or through the use of a planter with integrated spreading of fertilizer. In either case, the amount of labour required should not be more than a day extra. Regarding the second aspect, actual output will determine the amount of harvesting-threshing-winnowing labour required. This part of the labour requirements has been recorded as 24 and 22 days for maize and sorghum respectively (Plath, 1982). There is no reason to think that this estimate has become outdated. This estimate is based on an average yield of only 440 kg of maize and 350 kg of sorghum per ha.

One might add that there is an additional labour requirement for the establishment and maintenance of soil conservation structures. This requirement can be considerable (Stocking and Abel, 1989), but in this case, the establishment is being paid for by the project and the maintenance is not an immediate requirement for obtaining increased yields, which are mainly due to the use of advanced inputs. The long-run impact of preventing soil losses are discussed in a separate context in section 5.3.

Thus, the labour requirement function in person-days under management using a higher level of inputs, L (HI), can be expressed as a constant requirement for seed-bed preparation etc. and a function of crop yield (Y) in the following manner:

$$L(HI) = (76-24) + 2 + 24 * Y/440 \qquad \text{(maize)}$$

$$L(HI) = (77-22) + 2 + 22 * Y/350 \qquad \text{(sorghum)}$$

The calculation for the "traditional" management alternative is the same, except for the additional two days for the provision of inputs.

It is now possible to summarize the financial information in a single table for maize and sorghum respectively. The yield figures for the "traditional" alternative are derived from table 5.2. by averaging over the five years sampled. The yield figures for "high input" management are derived on the basis of a requirement put on the real marginal rate of return, which is here assumed to be 10 percent. This would cover e.g. a loan from the Lesotho Agricultural Bank, which has a nominal rate of 21 percent (LADB Mohale's Hoek Manager, November, 1990). With an inflation rate of 15 percent (Central Bank, 1990) this implies a real rate of about 6 percent.

Table 5.8 Financial Comparison of 1 ha of Maize:

	High input	Traditional	Diff.
Grain yield (kg/ha)	1406.00	626.00	780.00
Price (M/kg)	0.54	0.54	0
Gross grain income (1)	759.24	338.04	421.20
Fertilizer	154.15	0	154.15
Seed	62.10	8.10	54.00
Bags	24.10	10.73	13.37
Sum cash costs (2)	240.35	18.83	221.52
Labour (days)	130.69	86.15	44.55
Daily wage	2.50	2.50	0.00
Labour cost (3)	326.73	215.36	111.18
Gross margin (1-2)	518.89	319.21	199.68
Net margin (1-2-3)	192.16	103.84	88.31
Gross mgn/day	3.97	3.71	0.26
Nominal IRR (%):	34	44	Marg: 27
Infl. adj.(%):	15	15	0
Real IRR (%):	16	26	Marg: 10

Some explanatory notes to the table are in order. The gross margin is the gross benefit (income) less the sum of non-labour cost. The net margin is arrived at by deducting labour costs from the gross margin. The nominal IRR is the net margin over gross costs. The inflation adjustment is based on Central Bank (1990). The real IRR is based on the inflation adjusted net income. In the "difference" column, the marginal IRRs are based, **not** on the difference in IRRs, but on the differences in costs and benefits between the two management options. It can be noted that the return per day is above the opportunity cost (M 2.5) in both alternatives. The same calculations are shown below for sorghum.

Table 5.9 Financial Comparison of 1 ha of Sorghum:

	High input	Traditional	Diff.
Grain yield (kg/ha)	1672.00	685.00	987.00
Price (M/kg)	0.46	0.46	0
Gross grain income (1)	769.12	315.10	454.02
Fertilizer	154.15	0	154.15
Seed	32.30	4.60	27.70
Bags	28.66	11.74	16.92
Sum cash cost (2)	215.11	16.34	198.77
Labour (days)	162.10	98.06	64.04
Daily wage	2.50	2.50	0
Labour cost (3)	405.24	245.14	160.10
Gross margin (1-2)	554.01	298.76	255.25
Net margin (1-2-3)	148.76	53.61	95.15
Return per day	3.42	3.05	0.37
Nominal IRR (%):	24	21	Marg: 27
Infl. adj.(%):	15	15	0
Real IRR (%):	8	5	Marg: 10

The farmer will have additional costs not shown here such as those for hiring of oxen to plow his fields, or the use of his own animals. This will bring down actual returns for the two alternatives, but will not affect the **marginal** return, which is the figure of prime interest here. Spraying with herbicides is very rare in both cases. Costs for tools are minor items and will not differ much between management alternatives. Weeding requirements are not believed to change significantly, as fertilizing helps the maize and sorghum plants as well as the weeds. If only a first weeding is undertaken, the net result of fertilizing is probably to the advantage of the cultural plant.

The financial calculations show that, given a target real rate of financial return of 10 percent, the yield of

maize and sorghum must increase by 125 percent and 144 percent respectively, under the kind of management recommended by the FISC project. This can be compared with the mean relative increase recorded during the five years of crop sampling in the project area of 77 and 68 percent respectively, as shown in tables 5.8 and 5.9. The figures are not strictly comparable, since there is only incomplete information as to the actual level of use of fertilizer and type of seed. However, the qualitative conclusion is that the demand for yield increases is substantial in order to meet a reasonable financial target. In addition, we have seen from the crop sampling that the variance of yield is quite considerable. This, of course, acts as a deterrent for investments in "high input" management. We will return to the actual adoption of recommended management below.

The calculations shown above do not include any revenue for crop residues, for the reason that they are grazed by anybody's livestock if left in the field. To the extent that crop residues are harvested and fed to the farmers own livestock, the increase in crop residue production should be included in the financial analysis. No statistical study is available on this point, and subjective assessments differ substantially. Assuming full harvesting of all crop residues for private use, the demand on crop increases for maize and sorghum respectively decreases to 93 percent and 89 percent, relative to the traditional level of yield. Still, this is a substantial demand to achieve, and will entail some additional labour costs for the harvesting of the increase in crop residue production. No adjustment has been made for this cost.

It is worth adding that the FISC recommended management includes structures for soil conservation that will marginally impinge on the area that can be cultivated. To some extent, this can be balanced by growing fodder on the structures. The net impact is so small that no attempt is made here to quantify the result.

The land tenure system might also affect the willingness to invest in agricultural improvements. Data on sharecropping and leasing in Lesotho is very scarce. Holland (1983) reports from a study covering, among other chieftainships, Siloe, which is now a part of the FISC

project area. In 1981, a 15 percent random sample of farmers showed land leasing to be insignificant (3 percent) but sharecropping to cover 22 percent of the fields. As the operator of a sharecropping field takes all the cost but not all the revenue, he is likely to invest less in inputs and management of the fields than is the case with owner-operated fields, which implies lower yields on sharecropped fields. This hypothesis was tested statistically by Majoro and Holland (1986), but was rejected in two (including Siloe) out of three areas.

5.2.3 Financial Returns to Other Crops

Although the farmers in the project area are traditionally focused on growing maize and sorghum, the project actively promotes the production of fruit and fuelwood trees and fodder grasses. This section discusses their financial profitability.

Fruit Production

The FISC project offers apple and peach seedlings at subsidized rates. Drought and livestock grazing are serious dangers to fruit growing, but are less of a problem around the homestead. A financial fruit budget for ten trees is given in the table below.

Table 5.10 Financial Fruit Budget: 10 Trees Planted

	Apples	Peaches
Seedling cost (M)	33	21
Survival (%)	50	50
Productive years[6]	4-20	3-20
Output (kg/yr).	140	120
Price (M/kg	0.85	0.75
Income (M/yr)	119	90
NPV (10 %, M)	532	422
IRR (%)	57	67

Sources: Snir and Holland (1983), FISC Management and own survey of local fruit market in 1990.

It appears that fruit tree investments are a very attractive alternative from a financial perspective. This accords well with project experience. NPVs are substantial, although they accrue over an extended time horizon. The real rate of 10 percent and current financial price of fruit has been used here, assuming that future prices will change in accordance with inflation. However, we have not taken into account the risk for theft, which is reported to be substantial. From an economic point of view, this is a transfer between consumers, and does not detract from the aggregate social benefit, unless policing costs are incurred. From a financial point however, the risk of theft may discourage the investment altogether. Project management report a pronounced resistance to the idea of planting fruit trees out in the fields for this reason. Marketing problems might also restrain the interest. Little is known about the market's absorption capacity, and local fruit competes with well-established channels of imported fruit from South Africa, produced with advanced horticultural methods.

6. The table shows maximum production after a linear increase from years 3 and 4. For details, see Bojö (1990).

Fuelwood Production

Farmers can buy fuelwood seedlings at a subsidized rate. On the other hand, government also subsidizes the sale of fuelwood from government managed woodlots, which depresses the market price for the product. The government fuelwood market price is M 22.50 per m^3 in 1990 (LHDA, 1990). Local prices may, of course, be higher as the availability of government marketed fuelwood is limited. Seedlings are subject to the threats of drought and livestock grazing. For planting around the homestead, prospects are generally better and the survival rate of 70 percent to maturity has been assumed, on the basis of discussion with project personnel. The tree volumes at various ages have been obtained from the Forestry Department of the Ministry of Agriculture for the most commonly distributed seedling (Pinus radiata). The NPV for harvesting options at age 8, 10 and 12 have been tried, and the maximum was obtained for latter age. In analogy with fruit tree production, a budget for fuelwood trees is shown in the table below.

Table 5.11 Financial Fuelwood Budget: 10 Trees Planted

	Pinus Radiata
Seedling cost (M)	0.5
Survival (%)	70
Harvest year	12
Output (m^3/tree).	0.15
Price (M/m^3)	22.5
NPV (10%, M)	6.39
IRR (%)	38

The IRR appears attractive, although the NPV is modest, given the fact that the investment is minimal. One should also recall that a floor price set by the government output has been used, and returns should therefore often be higher. The real rate of 10 percent and the current price of output has been used, under the assumption that the financial fuelwood price will change to compensate for future inflation. In the experience of the project,

planting around the homestead is popular, whereas planting in the fields is less attractive to farmers.

Fodder Production

Hahn (1990) has studied the option of fodder production in the FISC project area. Adjusting his fodder production budgets so they compare with those for maize and sorghum presented above, the net margins for fodder would be competitive. Triticale and Eragrostis grass show net margins of M 222 and M 273 per ha respectively. This can be compared with the net margins shown for maize and sorghum in tables 5.8 and 5.9. The results for Lucerne and Banagrass are better still, and would seem to constitute a strong incentive for fodder production.

As will be discussed in more detail below, the adoption of fodder growing has not been particularly strong. Hahn (1990) presents the following reasons for this, based on his own interviews with farmers. First, marketing of fodder is known to be a problem. The buyers are few and far between, as local livestock owners resort to "free" grazing of natural grass and crop residues. Second, fodder crops are very dependent on good rains, and therefore exposed to substantial risk. Third, fodder crops are not always respected as a "personal" crop as maize and sorghum, and night-grazing by other animals is a source of concern. Fourth, there is limited knowledge of fodder growing in Lesotho, and many farmers quote this as a reason for abstaining. It seems that this obstacle should be overcome if incentives were strong enough, but the previous reasons act as a deterrent on experimentation. In the project's experience, the farmer response to fodder growing has been somewhat reluctant.

Alternative Investments

The funds that the farmer invests in improved inputs of any kind have a financial opportunity cost, i.e. they could have been used for some other purpose. For a low-income household, the most apparent alternative is to consume the income immediately. Putting the money in the bank is not a very attractive proposition in Lesotho, as real interest rates on savings in commercial banks are slightly negative (Central Bank, 1990).

Another alternative is livestock rearing. Swallow et al (1987) reports annual financial rates of return to investment of approximately 7, 8 and 10 percent for sheep, cattle and goat enterprises respectively, on the basis of an extensive survey covering all parts of Lesotho. Hahn (1990) reports from a smaller scale survey in Mohale's Hoek. He concludes that investment in sheep has a return of about 14 percent, while the return on goats is negative: minus 6 percent.

If the price of livestock follows the rate of inflation, these rates can be taken as real rates of return to the enterprise, disregarding the exact timing of income during the year. Available price data are incomplete, but BoS (1986) shows that prices from 1976/77 to 1984/85 have changed quite erratically. Nominal prices have even declined between some years, while rising by as much as 171 percent in one year. The role of livestock investment as an "inflation safe store of wealth" may still be applicable. A simple regression of nominal prices for bulls, oxen, cows, sheep and goats respectively on time shows average annual price increases of 11-17 percent, as compared to an average rate of inflation of 14 percent for the years considered. No doubt, investment in livestock is perceived as an attractive alternative by Basotho, as the increasing numbers (see chapter 3) are showing.

5.2.4 Summary of Financial Analysis

While the overall conclusions are postponed to the chapter summary in section 5.4, there needs to be a brief assessment of the results so far.

It is well known that yields of maize and sorghum have a high variance in general in Lesotho agriculture, and it has been shown here that the variance is also considerable for those farmers adopting "high input" management. It has been shown that investments in grain production in accordance with project recommendations put very high demands on yield increases. One can therefore understand if farmers are reluctant to invest in fertilizer and hybrid seed for maize and sorghum.

Fruit trees give high financial returns to subsidized seedlings. When planted around the homestead, supervision

can improve survival rates and discourage thefts enough to make it an attractive option. If the high returns calculated here can be realized, there should be an incentive for private suppliers to substitute for the project on more market based conditions. The full cost of seedling production and distribution is not known, but current returns leave considerable scope for financing of commercial production and distribution. If this is viable, the project can leave the market to take care of this item, and concentrate its efforts on other matters. Trees planted for **fuelwood** give slower and lower returns than fruit trees per invested Loti, given the assumptions used here. However, local prices may vary considerably.

Fodder growing appears financially attractive in comparison with grain production on crop land, but is hampered by the lack of an established market, high variance in yield, illegal grazing and a lack of practical experience on the part of farmers.

5.3 Economic Analysis of the FISC Project

The previous section deals with FISC from a household perspective. This section goes on to consider the economic perspective, primarily relevant for the Government of Lesotho, the donor organization, SIDA, and the executing company, Swedforest Consulting AB.

The section is basically organized according to the disposition introduced in chapter 4 and utilized in previous sections of this chapter. The exception from the uniform treatment of themes is the point about income distribution. This does not enter into the financial perspective at all, but is dealt with after the completion of the base case calculation, in this section.

5.3.1 Evaluation Criteria

The aim of the economic analysis is to check what surplus society could be expected to gain over the life-time of the project's impact. This is captured by the Net Present Value (NPV), as discussed in chapter 4. The NPV will be expressed in 1990 prices. Adopting a common accounting convention, all costs and benefits will be regarded as occurring at the end of each calendar year (Gittinger, 1982).

It is of interest to compare the yield of resources invested in the FISC project with alternative investment opportunities. This is done implicitly by using a real social opportunity cost of capital discount rate, but it can also be done more explicitly by calculating the economic Internal Rate of Return (IRR) of the project. The purpose is merely to get an indication of whether the return has been in a competitive range, not to rank projects.

Explicit consideration ought to be given to the distributional impacts of costs and benefits. When using the conventional formula for NPV calculation, this is done by weighting the impact of a one dollar cost or benefit equally, regardless of to whom it accrues. In the case of Lesotho, there is good reason to pay attention to this issue, since the distribution of income is quite skewed, as discussed in chapter 3. For practical reasons,

this point will be brought up again in section 5.3.7, after valuation has been done using conventional "unweighted" data.

5.3.2 Identification of Costs and Benefits

Financial costs are identified through project and donor accounts. There are also costs for maintenance of soil conservation works. These are borne by the farmers, and have to be estimated separately. However, financial costs have to be adjusted in several ways to arrive at real economic costs (see section 5.3.4). Benefits are easy to identify, but harder to quantify. Below is a list of potential benefits that have been examined. The project aims at increasing production of:

(1) Maize, sorghum and crop residues due to the use of fertilizer, hybrid seed and conservation of soil and nutrients;

(2) Fruits: peaches and apples;

(3) Fuelwood from pine and other tree species;

(4) Fodder grasses such as Eragrostis and Bana grass;

(5) Vegetables from communal gardens sponsored by the project;

(6) Livestock products by promoting improved grazing management.

Additional benefit items to consider are:

(7) Training of personnel, and the introduction of improved communal management, with potential **extra-project** impacts;

(8) Off-site physical impacts, such as less siltation of dams, less maintenance costs for roads and bridges, improved water quality etc;

(9) Secondary benefits for the community at large as a result of the increase in income from agriculture.

5.3.3 Quantification of Costs and Benefits

Not all costs are readily available in monetary terms. Examples are the temporary loss of soil from new, ungrassed terraces, "loss" of land to terraces and other structures[1] and increased maintenance for roads due to greater use. However, the project encourages productive use of structures for fodder growing, and the net costs of these items are so insignificant that they have been excluded from further calculations.

An item of potential but disputed importance is labour costs for the maintenance of soil conservation structures. The project manager (Gedion Shone, letter to the present author, May 9, 1991) estimates that the labour required per conserved hectare of land amounts to about one person-day per year for the first two years, and half of that for the years thereafter. This estimate is dependent on "normal" rainfall intensity after construction and establishment of grass cover, average slope in the area and proper alignment of the structures. It is believed that such maintenance on own crop land occurs, but that additional work on communal structures rarely takes place. The qualitative conclusion is that the labour effort is negligible per hectare of conserved land.

However, this estimate differs widely from Michael Stocking's (soil scientist and former consultant to the project, letter to the present author, May 7, 1991). He estimates that terraces only, require some 15 person-days per hectare for their maintenance on a typical 10 percent slope. The entire system of conservation works may need another 3 person-days per hectare. Requirements will vary considerably according to slope and labour productivity.

In the absence of empirical measurements on this point, the judgement of the person with most direct experience of the project area (the project manager, Gedion Shone) is accepted in the base case. Therefore no maintenance cost is enclosed, as the item is negligible. However, we should remember this underestimate as the base case

1. The Lesotho word for buffer strips is "makorota", loosely translated as "field reducers" (Chakela and Cantor, 1986).

result is evaluated later on. Furthermore, we take note of the obvious need for some empirical research on this potentially important point.

The Cost Data

Monetary cost data were taken from project accounts and complemented by the executing company's (Swedforest Consulting AB) data for costs paid by the donor agency directly to the company. FISC accounts are in Maloti (M), Swedforest accounts in Swedish kronor (SEK). The exchange rate for 1985-86 is based on a weighted average of the actual rate at the exact date of purchase of Maloti. Thus, the official exchange rate has been used, for reasons further discussed in section 5.3.4. For 1987-89, an annual figure has been assigned, based on IMF (1990). The figure for 1990 has been set to SEK 2.3 per Loti, in accordance with FISC (1991). For 1991-92 and onwards, the exchange rate has been assumed to change in order to balance differential expected inflation rates between Sweden and Lesotho. The inflation rate in Lesotho is expected to remain at the current 15 percent (Central Bank, 1990), and the rate in Sweden to be 9.5 and 3.7 percent respectively in 1991 and 1992 (KI, 1991).

If, for example, the inflation rate in Sweden goes down even further, the exchange rate in SEK per Loti will fall even more, and project costs in Maloti will register a rise as the budget remains fixed in SEK. However, as explained further below, the expected size of several benefit items is linked to the projected financial costs in Maloti. This tends to stabilize the net result for changes in inflationary assumptions.

The time unit used in the economic calculations is calendar year. This differs from FISC project accounts, reported monthly with April 1 as the starting point of accumulation. It also differs from the agricultural year, August 1 - July 31. When this period of accounting is used, it is denoted by 1985/86 and so on.

Table 5.12 Financial Project Cost (000 Maloti)

	Nominal	Real (1990)
1985	585	1 092
1986	624	1 027
1987	922	1 357
1988	1 052	1 390
1989	963	1 108
1990	1 808	1 808
1991	2 358	2 051
1992	1 568	1 363

Sources: Author's calculations are based on project accounts for March 1985 - December 1990, the budget for 1991-92 in FISC (1991) and inflationary assumptions as described in the text above.

The incurred and currently foreseeable **donor** funded costs, in 1990 prices, sum to about M11 million, which is about SEK 25 million or almost USD 4 million. As for the time after mid-1992, there is no decision yet as to further donor involvement. If project activities are to continue with domestic (or possibly other donor funded) resources, these costs will have to be set against any additional benefit items. We will return to the issue of the long term perspective after having considered the benefit side.

The Benefit Data

The benefit categories identified in the previous section will be evaluated, first in physical terms. In section 5.3.4 prices will also be attached to them.

Crop Benefits

Maize and sorghum are the crops that will be considered for quantification. Other crops, such as beans, peas and winter wheat are of minor significance and will be left out of the study. Crop benefits will be considered in two parts:

a) incremental yield in the "high input" scenario, relative to a constant base level;

b) incremental yield due to conservation, relative to future decline in yield due to erosion.

The term High Input Crop Benefit (HICB) will denote benefit type (a) and Conservation Crop Benefit (CCB) will denote benefit type (b). Consider first the **High Input Crop Benefit** (HICB). Maize and sorghum experience different yield improvements and have different prices, making separate considerations necessary. For the respective crops, all land in the project area is subject to the average productivity improvement. The **incremental** crop **production** resulting from the project is:

$$IQ_{it} = HIY_{it}/TY_{it} * AY_i * AH_{it} * PI_{it} * CS_i$$

where

IQ = incremental production (kg);

HIY = high input management yield (kg/ha);

TY = traditional management yield (kg/ha);

AY = the base level of average (14-year) yield for the district (kg/ha);

AH = area using "high input" management (ha);

PI = project impact: the share of AH affected by the project's actions (percent);

CS = the share of maize and sorghum respectively of the cultivated land (percent);

t = time index (year 1 ... T);

i = crop index.

In practice, the details of this equation become less important than previously thought, for the simple reason that it can be assumed that PI = 0. It should not be automatically assumed that the change in yield between the "high input" and "traditional" scenarios is due to the project. Some farmers would have used fertilizer and hybrid seed even without the project.

The input delivery records of the project show that only some 55 tons of fertilizer were sold or handed out as incentives in 1989/90. This is sufficient to cover only 220 ha with the recommended dose of 250 kg/ha, which is less than 2 percent of the cultivated area in which the project is active. Similarly, the amount of hybrid maize seed is only sufficient to cover 150 hectares or about 1 percent of the cultivated area. The figure for hybrid sorghum seed is only 10 ha. These deliveries are not likely to understate the true flow of inputs to the project area considerably, as there are no private traders providing alternative outlets. The only alternative source is Coop Lesotho, which has two depots in Mohale's Hoek town. Supplies from these would be more expensive or inconvenient than obtaining inputs from the project.

The number of receivers of in-kind payments plus the number of households (maybe overlapping) purchasing inputs for cash was 634 in 1989/90 according to project records. It is not possible to differentiate the exact numbers of households for each category of inputs with available documents, but quantities imply that fertilizer strongly dominates in supply. In terms of the shares of households involved, this corresponds to about 14 percent of the recorded households in the project areas. This coverage must be put in relation to a plausible figure of input use without the project. Three previous studies of relevance have been found.

The first is Holland (1983). Data are reported from three prototype areas in Lesotho surveyed in 1981, one of them being Siloe, where FISC has recently begun activities. In a sample of 79 maize growing farmers, 34 percent reported use of "commercial" maize seed and in a sample of 114 sorghum growing farmers, 11 percent stated use of "commercial" sorghum seed. It should be noted that "commercial" does not necessarily imply "hybrid" seed, as other varieties are also on sale. However, it appears reasonable to assume that farmers generally turn to commercial suppliers to get the hybrid varieties they cannot obtain from own production or other local suppliers. In a sample of 172 farmers in Siloe, only 6 percent reported using "chemical fertilizer". It should be recalled that the survey is now ten years old, and

that the quantity of fertilizer used per area unit has shown an increasing trend since then - see chapter 3. This does not prove that the relative share of **users** has increased, but this is nevertheless very likely to have happened.

The second study of relevance here is Yaxley (1987). Surveying an area in the vicinity of Maphutseng, he found that 31 percent (1985) and 28 percent (1986) of 81 interviewed farmers stated use of "improved" seed. Yaxley also reported relative use rates for "commercial" fertilizer from the same sample of farmers as 46 percent (1985) and 48 percent (1986). No information is available on the quantities.

The third available study of relevance to input use in a "without" project situation is Mashinini (1988). He reports from a sample of 60 farmers in an area now covered by the FISC project. The stated use of "chemical" fertilizer was 20 percent. As for seed, the responses are difficult to interpret for our purpose, as the "source", not the "type" of seed was asked for. A total of 26 percent used "bought" seeds, of which 13 percent came from Coop Lesotho. This is at least an indication of the level of hybrid see use. Quantities are not known.

In summary, the data from the three referenced studies and project records are not strictly comparable in classification. Different time periods are involved and only relative shares of input use among farmers can be compared. Reported use levels also vary considerably. However, the **most likely** situation is that **the project has only substituted inputs** that otherwise would have been bought on the regular market. This makes sense if risk-avoidance is the major factor restraining input use. While this is the most likely assumption, and therefore used in the base case calculations, we will return to the question of a possible increase in crop production in the sensitivity analysis below.

Consider now **Conservation Crop Benefits** (CCB). Firstly, we need to consider whether soil loss actually affects crop production at all in this particular area. Secondly, if it does, to what extent soil loss occurs, and thirdly, how this rate affects productivity.

An important reason why yields drop because of soil loss is that the water retention capacity is reduced. Stocking and Pain (1983) present tables from which the minimum soil depth requirements for different crops growing on different soils can be assessed. For sorghum, and soil conditions relevant for Lesotho, the yields are expected to drop from about 27 cm of soil depth, due to lack of water retention capacity. The figure for maize is slightly lower. Based on detailed field knowledge of the Maphutseng area, Rydgren has estimated an average topsoil depth of about 25 cm. Naturally, the range is quite extensive, in Maphutseng and in other project areas. The important point is that this implies that water retention capacity has become, or is about to become a critical factor for the growth of maize and sorghum, given the type of soils in the area. Thus, there is reason to believe that soil loss immediately affects the average crop production area within project borders.

Secondly, the evidence of actual rates of soil loss in the project area needs to be considered. There is data from the pilot project area of Maphutseng, through field measurements made by Rydgren (1986). Based on these, and on his continued field experience until present date, he has estimated that roughly about 15 t/ha is lost on poorly managed soils versus 5 t/ha for the areas under project influenced conservation management.

The figures for soil loss should be adjusted for the rate of soil formation, in order to arrive at a net loss of soil. In general, a tolerable soil loss in t/ha/year - or T-value[2] - is regarded as the rate of loss that implies a zero net loss of soil (Schertz, 1983). The soil loss tolerance is defined as "the maximum rate of annual soil erosion that may occur and still permit a high level of crop productivity to be obtained economically and indefinitely" (Schertz, 1983, p. 11, quoting Wischmeier and Smith, 1978). In the absence of technical change, this implies a zero net loss of soil.

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2. This kind of "T-value" bears no relation to the "t-value" used in statistical tests of significance. T-values are absolute standards that ignore the possibility of alternative measures for yield maintenance as well as the timing aspect of conservation measures. See Crosson and Stout (1983) for a discussion.

It is questionable, however, whether the often quoted definition above is interpreted in a strict sense. **Soil** formation is much slower than **topsoil** formation. It appears that the generally used T-values are based on the latter rates rather than the former. (Ibid.; Crosson and Stout, 1983). This implies that the rooting depth would be allowed to deteriorate, which contradicts the definition's call for sustainability "indefinitely".

Cauley (1986) has published T-values for the benchmark soils of Lesotho. Applying these T-values to Maphutseng soils, the best mapped project area, one can classify about half in the T=7 category and about half in the T=2 category. This implies that poorly conserved "traditional" management fields will be subject to a rate of net soil losses in the order of 8 - 13 tons/ha/year, with an estimated average of some 11 tons/ha/year.

However, the use of such T-values is controversial. Rydgren (personal communication) maintains that topsoil formation in the area is considerably below the quoted T-values. Therefore, the simplifying assumption of 15t/ha/year of soil lost will be applied to non-conserved areas. It should be added that even the areas under project conservation management, in this case, make a net loss of almost 5 t/ha/year. This implies that the conservation benefit computed below will be slightly overstated, as it is based on the approximation of a constant yield level as a result of conservation measures alone. However, further refinement on this point would not alter the qualitative results.

Thirdly, we come to the quantitative question of how the amount of soil loss affects yield. The decline in yield per annum is difficult to assess. Very little has been done to shed light on the economic consequences of erosion in Lesotho, although it has had a soil conservation programme since 1935. Most erosion research has been confined to physical aspects of the erosion process itself, rather than its implications for production. Our own efforts in chapter 3 to capture the national cost of soil loss to crop land in Lesotho, gives only some rough guidance as to the interval of average **national** impact, but local conditions deviate substantially.

A search for empirical studies that relate soil erosion to crop yield in Lesotho has not resulted in anything tangible. Several attempts have been made to solicit opinions from some of the leading scientists and practitioners in the field in Lesotho, but little guidance has been obtained.[3]

The lack of information available locally or nationally on erosion-yield response functions demands reference to studies from other parts of the world. Our survey in chapter 4 shows that only three studies out of 20 explicitly quantify their soil loss-yield impact assumptions in a manner that is useful for our purposes. Their assumptions will be shown below.

Before we enter into the empirical details, a general word of caution is warranted. There is no simple relationship between soil loss and production, although a simple linear function may sometimes serve as a proxy (Hurni, 1985). Furthermore, soils differ much in their characteristics: some have their nutrients concentrated to the upper layers to a very high degree, others with a more even spread of fertility. The latter seems to apply to the soils in the project area in general (Stocking, personal communication). This makes a linear approximation more reasonable than otherwise. Third, different crops may be influenced differently by the same rate of soil loss, as the necessary rooting depth differs, as well as demand on water retention capacity. In summary, soil loss-productivity relationships are best established as an assessment of a particular crop on a particular soil given a particular level of technology and other exogenous factors (Stocking and Pain, 1983).

There are of course other studies relating maize or sorghum production to soil losses, outside of the cost-benefit framework. A frequently quoted study by Lal (1981) reports losses in maize yield of 3, 3, 4 and 16 percent per year for four different plots, for a soil loss of 10 t/ha/year. However, the data refers to a soil type in Nigeria that is much more likely to experience

3. References have been made to Ministry of Agriculture (1981). However, this source contains no research done in Lesotho, and its extrapolations from scanty data from South Africa and India are not convincing.

rapid yield decline even for moderate rates of erosion (Stocking, personal communication).

The results from India are probably more applicable to Lesotho conditions, (Vittal et al, 1990), and are included below. In addition, Lyles (1975) has put together a large number of studies from the USA, (of which six sources deal with maize and three with sorghum) from which we can take the averages. A few other studies give comparable data which is summarized below in table 5.13.

Yield losses are sometimes quoted in weight per ton of soil lost, sometimes per mm soil lost and sometimes as a relative decline in harvest per unit of soil loss. Given the tremendous differences in yield levels, it appears that the most useful figure from a comparative point of view is the yield loss in **relative** terms per unit of soil loss. As the net loss in the area under consideration is 11-15 t/ha/year, and 13 tons correspond to one mm, this measure is used for comparison below.

Table 5.13 Soil Loss - Yield Relationships

Source	Relative yield loss % per mm soil loss
Hurni (1985)	0.2
Lal (1981)	3.9-20.8
Lockeretz (1981)	0.1
Lyles (1975)	0.2
Nobe & Seckler (1979)	0.001-0.5
Swanson and Harshbarger (1964)	0.1-0.2
Vittal et al (1990)	0.8
Wiggins (1981)	0.2

The studies refer to maize (or "corn"), with the exception of Vittal et al. (sorghum) and Hurni (barley). Lyles reports the same average relative loss for sorghum and maize. All studies, except Lal's, which we have reason to consider less relevant for Lesotho, show impacts with an order of magnitude of fractions of a percent rather than whole percentages per year and mm

soil loss. In order not to exaggerate the degree of exactness, the figure is rounded off to 1 percent in our base case calculations.

The figure of a 1 percent annual decline from the previous year is applied equally to maize and sorghum. This corresponds to an initial loss of approximately 7 kg/ha of maize and 8 kg/ha of sorghum based on the 14-year historical district average. The assumption regarding production impact will be subject to sensitivity testing, since there is much uncertainty about this figure (see section 5.3.8).

To return to the equation for incremental crop production above, this can now be modified for CCB:

$$IQ_{it} = dY_{it} \times AYi \times \Sigma AC_t \times PI \times CS_i$$

where

dY = relative crop decline avoided due to conservation;

ΣAC = accumulated area under the conservation management (ha).

Other denotations are as explained for equation (I). The assumption here is that PI (project impact) = 1.0, as conservation activities are assumed to be nil in the absence of the project.[4]

The production of crop residues is quantified on the basis of Plath (1982) as a grain/crop residue ratio of 2/1 for maize and 2.5/1 for sorghum. The latter is also supported by Anderson (1987).

This equation is applied for the project period 1986-92. As for the period after 1992, this will be discussed jointly with the perspective on other benefit items below.

Fruit Tree Benefits

After an initial period of investment, the nursery has now started to deliver a considerable number of seedlings

4. This is supported by Rydgren's observations during field work in the area before project initiation.

to farmers as part of the project incentive package. The seedlings are mostly peaches (about 2/3) and apples (about 1/3). Deliveries so far are shown in table 5.12.

Fruit tree planting for 1991-92 is expected to develop in proportion to the availability of financial means to the project. Leaving 1985-86 aside as starting years, the average performance during 1987-90 forms the basis for such projections. The fact that future figures have not been rounded off should not convey a false sense of accuracy about the forecast.

Table 5.14 Fruit Tree Deliveries from the FISC Project

	Peaches	Apples	Total
1985	0	0	0
1986	0	0	0
1987	2 757	1 448	4 205
1988	1 586	800	2 386
1989	1 200	675	1 875
1990	2 000	1 600	3 600
1991	2 916	1 458	4 374
1992	1 438	719	2 157
		Total:	18 633

Source: Project records and author's projection.

The number of surviving trees at age of production is expected to be approximately 50 percent, as cattle grazing is a severe problem (Project Team Leader, personal communication). Production per fruit tree has been discussed as a part of the financial analysis in section 5.2. Assumptions for the post-1992 period are discussed below.

Fuelwood Benefits

A considerable number of fuelwood trees have been planted by the project. These have mostly not been produced by the project nursery, but purchased externally. Most of the trees planted are pine (about 70 percent) and the remaining are mostly acacia varieties. It has not been

possible to get a complete record of the number of trees planted of each species, and pine trees are used as a proxy for all trees in the ensuing calculations. Assumed survival rates until maturity are indicated below. The first year's rate is low (50 percent) due to an exceptional drought shortly after planting. On the other hand, conditions were unusually favourable (70 percent survival rate) for the ensuing two years. Something in between can be expected for the future.

Trees are not only threatened by drought and grazing cattle. Fire has plagued many plantations in Lesotho, and Maphutseng is not an exception. Some 760 trees were destroyed in a fire in September 1989 (FISC Monthly Project Report). The cause of the fire remains unclear. If the fire is an expression of negative sentiment against tree planting - which competes with grazing land - it may not be an isolated incident.

The harvesting of pines is assumed to take place in year 12 in which the trees are assumed to have an average volume of 0.15 cubic meter (John Bazill and David May, Forestry Department, MoA, personal communication).

Actual data are available in project records for 1985-90. As for the remaining project period, the forecast will be based on a proportionate change in relation to the availability of financial means in 1991-92. The period after mid-1992 is discussed below. It is interesting to note that the performance in 1990 much exceeded expectations in 1989. It was then believed that resistance to tree planting would be considerable in the new project areas.

Table 5.15 Fuelwood Tree Production

	No. Planted	Survival Rate	No. Mature
1985	0	-	0
1986	11 000	50%	5 500
1987	24 300	70%	17 010
1988	23 000	70%	16 100
1989	23 000	60%	13 800
1990	61 200	60%	36 720
1991	43 679	60%	26 207
1992	25 251	60%	15 151
Total	209 233		129 170

Sources: Project records (1985-1990) and author's forecast (1991-92) in proportion to budget means, given past record.[5]

There is a small opportunity cost attached to the planting of trees due to lost grazing areas. However, the spacing of the trees is very wide, and the loss is insignificant in this case.

Fodder Benefits

The area for fodder grass production so far has been very small, in spite of vigorous project promotion including seed and root stock provisions on credit. Some 5 hectares are used for Eragrostis, and some 6 hectares are used for Bana grass. An insignificant area is covered by Elephant grass on an experimental basis. These areas are regarded as net additions due to project influence, as there is no tradition of fodder grass cultivation in the area. Night grazing is a persistent problem. For the remaining project period, it is assumed that areas will change according to the financial strength of the project.

Fodder yield per ha has not been systematically sampled. The only field data available from the project area is

5. Aggregated data for 1988/89 has been evenly split between the years as an approximation of actual distribution, on advice from the project counterpart horticulturist.

from Gebregziabher (1989), who sampled one area of 0.5 x 10 m of Eragrostis curvula. The result was a yield of 7.5 tons of dry matter per ha. However, this stand had been fertilized at the beginning of the growing season. In general, farmers are not expected to fertilize their fodder. The only empirical evidence from the area is based on a sample of one, and reported in Hahn (1990) as about 3.4 ton/ha for Eragrostis and about 6 ton/ha for Banagrass.

An opportunity cost is charged to the fodder growing operation, the result of which is diminished crop land. The land concerned carries relatively poor crops. It is estimated that they would have an output of about 75 percent of the average crop land (FISC Team Leader, personal communication). The opportunity cost depends on what crop would have been grown. It is assumed that sorghum land is first taken out of production for fodder growing. This accords with informal evidence that maize is the preferred crop, even in the face of climatic obstacles. This means an opportunity loss of sorghum production of 0.75 * 685 kg = 514 kg/ha (see table 5.9.) This opportunity cost will be charged against fodder income. Differences in the production cost of fodder and sorghum are ignored here.

Other Potential Benefits

Vegetable production is very limited so far. Communal gardens have been encouraged by the project, with generally poor results. A few hundred Maloti worth of vegetables have been produced in Maphutseng, but there are no major benefit items to include so far in our CBA. The potential here remains very uncertain. Most likely, the gardens will not continue to operate when project support is withdrawn.

The introduction of improved communal management of grazing land has a direct impact on livestock production, and a potential spin-off effect for areas not directly involved in the project. The grazing improvement so far achieved is in the form of rotational grazing in about one third of the grazing areas and a limited, and only partially respected, regulation of grazing in areas where trees have been planted. Suggestions for more advanced cut-and-carry systems, or marketable grazing rights

(Klosterman, 1983; Reynolds, 1988; Mashinini et al, 1989) have not been implemented. The project should be credited for its promotion of the discussion on these points, but there are no results on which to base any calculations.

The project pays substantial attention to the training of local staff and villagers. The training given to personnel is largely confined to application in the project area. Training was initially focused on matters directly pertaining to soil and water conservation, but has been broadened to include matters of resource management more in general. The benefit of this training is captured in the extent to which production will be raised in project areas. However, the extension agents, conservation assistants and organizers may be moved to external areas. Thus, a potential, external training benefit should be noted as an intangible. It is impossible to quantify this benefit, but the number of trained personnel that has moved out from the project areas is small, and the omission of this benefit item is unlikely to be serious, for the time being. However, the FISC Project has become something of a national training model. The previous FISC Team Leader has, as of early 1991, taken up a position as a national level adviser to conservation training activities in Lesotho. It is too early to judge the success of this programme, but there is a potential for benefits to appear as a result of the methods development done in the core project area. For the time being, we note this as a potential, intangible benefit item.

Maintenance of roads and bridges in the area will not be significantly affected by the improved land management and soil retention. There are no major dams for hydropower and/or irrigation in the project areas that will be affected. The irrigation potential from natural springs will be developed by the project in support of communal gardens. However, there are no significant activities of this nature observable at present. Improved water quality will have an aesthetic value, and may slightly affect washing facilities. Water quality for cattle may improve. Drinking water will not be significantly affected as there are better alternatives available through hand pumps already installed in the areas concerned, as a result of yet another aid project.

Secondary community benefits (multiplier effects) are likely to arise as the level of consumption is raised through the increased agricultural income. In an extremely import dependent economy such as Lesotho, very little of this will be retained as local income and employment. A substantial part of it will leak out to the Republic of South Africa. Given the current (early 1991)[6] sanctions against the RSA imposed by Sweden, this is a cost rather than a benefit from the point of view of the donor. Although SIDA tries to restrain direct project purchases from the RSA, there is nothing that can be done about increased consumption of South African goods as a result of raised incomes in Lesotho.

The Long Term Perspective

One item has repeatedly been put off until later, but must now be faced: what will happen after mid-1992? There are two general possibilities (1) SIDA (or a substitute donor) continues its support to FISC and (2) the project is discontinued. If the first alternative is realized, there will be additional costs to achieve the additional benefits. If the external support to the project is discontinued, Lesotho will have to manage on its own. Will the benefits be sustained? If so, at what domestic resource cost?

The current (early 1991) situation is one where SIDA and the Government of Lesotho are about to negotiate a possible continuation of the project. Therefore, it is reasonable to ask the strategic question: should donor support be discontinued? We start by outlining the alternative where donor support is discontinued.

As for costs, it is assumed that domestic authorities try to uphold the services provided by the project, using buildings, vehicles and other resources left behind by the project. In previous analyses, the salvage value of these items were credited to the project, as comparable activities were assumed to cease. On the basis of more recent experience, a more optimistic assumption is made here, but then the credit item disappears as the resources are now put to work in the domestic continuation of the project. The level of costs is

6. On this point, Swedish policy may change quickly in response to the ongoing political changes in the RSA.

assumed to remain at the average for 1985-1992[7], but with all costs associated with expatriate (non-domestic) services, such as consultant fees, back-stopping by Swedforest, external evaluation missions etc. taken out. The share of costs remaining is 54 percent.

It is assumed that the project continues to add newly conserved crop land at a performance rate of 50 percent of the previous level. However, from the accumulated area under conservation management reached the previous year, a decline rate of 2 percent per year is applied. This is due to lack of maintenance of primarily communal soil conservation works, and some plowing up of terraces. Maintenance of structural soil conservation works is labour intensive[8], and not all households can be assumed to have the necessary resources to carry this out themselves, or to employ outsider labour. Another assumption is that there will be no lasting impact on the use of fertilizer and hybrid seed.

Furthermore, it is assumed that distribution of fruit trees continues but declines to a level of 50 percent of project maximum. The argument is that the running of a tree nursery requires certain skills that are in scarce supply, and that distribution will be damaged if the project channels are withdrawn.

For fuelwood it is assumed that tree planting declines to a level of 50 percent of project average achievement in 1986-1991. The withdrawal of project support would drastically decrease supply capacity for tree seedlings. Village nurseries have so far been unsuccessful. Other sources of supply are functioning less well.[9] The conflict between grazing land and land for trees (implying controlled grazing) will also become more acute.

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7. The years 1985 and 1992 are counted as half years as the project started into 1985 and is scheduled to finish by the middle of 1992.
8. Stocking and Abel (1989) present a summary of studies of labour requirements depending on type of structure and slope.
9. A national tree planting programme might change this situation, but will in that case be associated with additional costs not accounted for here.

For fodder grasses, the assumption in the base case will be that fodder growing stabilizes on 50 percent of the level achieved in 1986-1991. There may be some plowing up of grass strips ("field reducers") when project staff have left. However, project management believes that fodder can be a reasonably competitive activity as compared to crop cultivation on marginal lands, and this is supported by Hahn's work (1990). In any case, this is not a very substantial project activity and alternative assumptions will not change the overall picture.

With these points, the list of potential benefits has been exhausted, and some of them found significant, others less important, in the further discussion. The main ones will be priced to arrive at a comparison between costs and benefits.

5.3.4 Valuation in Economic Prices

The basic concern addressed in this section is how to price inputs and outputs so that consumers' willingness to pay is properly reflected. A natural starting point is the financial price, if there is one, and then to discuss what distortions might call for an adjustment to arrive at the economic price. The pricing of foreign exchange is an overriding issue. Adjustments for import tariffs will also be discussed. Shadow pricing of labour and agricultural inputs will be considered. The trends of prices will be discussed, and nominal prices will be transferred into real (1990) prices.

Foreign Exchange

Most developing countries have foreign currency markets characterized by severe imbalances and heavy government intervention and black currency markets. However, Lesotho does not fit this description. The Loti (pl. Maloti) is fixed on a par with the internationally convertible South African Rand. The Rand is tied to some, but not extremely extensive restrictions. There is a two-tier market in that a Financial Rand is available for foreign investors at a premium, but all others have to buy the Commercial Rand. As the premium was only some 18 percent in 1988 and has since declined, the amount of trading in Financial Rands has been very limited (Central Bank, 1990). It can

still be argued that the Commercial Rand is overvalued, and by implication therefore the Loti as well. However, there is no black market for Rands or Loti. Theoretically, this could be the result of strict and severe law enforcement, but this argument is not convincing in the case of Lesotho. This indicates that the distorting impact of foreign exchange restrictions is not significant. No official guideline is available as to shadow pricing of foreign exchange.

Trade barriers, such as tariffs and quotas also affect the relation between domestic market clearing prices and import prices. There are substantial trade barriers around the Southern African Customs Union, of which Lesotho is a member together with South Africa, Botswana and Swaziland. The price raising effect for Lesotho has been estimated to about 23 percent (Kizilyalli, 1982). Lesotho does not directly receive import duty on its own imports, but through a complex revenue sharing formula. Kizilyalli finds that the actual compensation rate was about 17-22 percent in 1974-1981. Lundahl and Petersson (forthcoming) report that the average compensation level is targeted to 20 percent of the cost of imports.

The common cost-benefit procedure would be to eliminate the transfer payment that the duty compensation constitutes, thus reducing import cost by 20 percent. The validity of this procedure depends on the exact perspective of the evaluation. The Government of Lesotho should rightfully subtract the customs compensation, as this does not represent a resource cost to the economy; this is valid both ex-ante and ex-post.

The issue is slightly more complex when looking at the donor perspective. From the perspective of comparing a project in Lesotho with alternatives in **other** developing **countries**, the full and unadjusted cost of the project has an opportunity cost in terms of other purchases foregone; a building built in Lesotho is a building **not** built in Tanzania, given the firm Swedish allocation goal of 1 percent of GNP to foreign aid each year. This type of comparison would be skewed if tariffs and other transfers were simply deducted from costs. But the perspective could also reasonably be taken that Sweden has allocated SEK X million on political grounds to Lesotho, primarily to further its independence versus the

powerful neighbour. Given this, the options are limited to different kinds of projects **within Lesotho**. Given the transfer of resources from Sweden to Lesotho, one should adjust for payments that do not represent real resource costs to the economy. This does not mean that the distributional impact of transfers is uninteresting. The purchase of tractors versus unskilled labour could entail the same amount of transfer, but to central government and to labour respectively.

The project produces outputs that are import substitutes. This is evident for maize, but is also true of e.g. fuelwood that will substitute dung and crop residues as a source of energy, making greater production of maize possible through manuring and retention of biomass in the fields. As discussed in chapter 3, higher domestic production of crops is likely to result in substitution of sources of supply, rather than an increase in demand. If imports drop due to project activities, Lesotho could (1) buy other imports instead or (2) divert previous exports to domestic consumption, and still maintain their balance of payment in long-run equilibrium. The marginal propensity to import other consumption goods is probably very high, whereas marginal diversion of exports appears much less likely. Assuming that FISC production allows for additional imports, the value of this is the domestic market price of these goods, inclusive of the tariff raising impact. There is no change for government, as the amount of imports and customs compensation is the same.

On the basis of this situation, the following approach will be taken here:

(1) Since there is a transfer of income to Lesotho of about 20 percent of the import value, inclusive of duties, the value of **imported** components is multiplied by a factor of 0.8 when going from financial to economic prices. This applies to building costs (where 80 percent is assumed to be imported material (CPDO, 1987)), vehicles, farm tools, nursery equipment and office supplies.

(2) No adjustment is made to the market price of project outputs.

(3) No adjustment is made to the official exchange rate of the Loti/Rand vs. other currencies.

Price Trends

The bulk of project inputs are confined to a short period in the beginning of the time horizon considered. Most of the project costs are already taken, and the best forecast available for the remaining investment period is the budget projections that the consulting company (Swedforest) managing FISC has made. However, an adjustment for inflation has to be made in order to arrive at real (1990) cost.

Project outputs are in this case to a greater degree sensitive to real price changes over a much longer period. It is therefore necessary to pay some attention to long term price trends. In this study, it implies a look at how the main project outputs are likely to be priced over time. This is discussed for each output below.

Labour Costs

In spite of considerable and chronic imperfections in the Lesotho labour market, there are no official guidelines as to shadow pricing of labour. Attempts to establish such guidelines have been made (Modiani, 1986; Taylor, 1985), but there is no official recognition of this. It therefore seems appropriate to apply a rate that appears reasonable depending on local circumstances.

Skilled personnel involved in the project operate on an international, competitive market. **Semi-skilled** personnel have access to the large South African labour market where the demand often drains Lesotho of valuable skills. These groups, including all project personnel paid on a regular, monthly basis (expatriate experts and counterparts, conservation organizers, secretary, drivers, storekeepers etc.) will be priced at their financial wage.

As for the **unskilled** personnel (farmers), there are payments in cash and in kind. The economic valuation is not dependent on the form the payment takes. The financial worth of both kinds of payment is M 3.5 per

"task" which is approximately the same as one "day" of work. The shadow wage rate will be set to M 2.5 as this, according to project personnel, is the generally accepted local wage rate when farmers hire casual labour. Although the high rate of unemployment, discussed in chapter 3, indicates a considerable slack in the labour market, there is disutility of effort involved. The exact mix of loss of leisure and non-marketed home production will vary across individuals, but the locally accepted wage rate should capture these concerns.

Material Input Costs

The FISC project demand is so small compared to the total market that only marginal extra quantities of farm and nursery equipment, building materials etc. will have to be produced. It is very unlikely that other consumers will have to forego their use of project inputs because of its demand. Thus, the marginal cost of the additional input production is the true opportunity cost. Assuming the marginal cost to be approximately constant over this small interval, this will be approximated with the market price without sales tax. There are no subsidies that would need to be added to the financial prices.

Other inputs channelled through the project are fertilizer and hybrid seed. These are used as payment for unskilled labour as well as sold directly to farmers for cash. The essential aspect here is what differentiates the situation with the project versus the one without it. Assume first that (1) there is no change in the use of inputs as a result of the project. In other words, **cash** payments are not particularly linked to such purchases, but are used for an array of other goods and services. In most cases we lack information as to what these may consist of, but if their benefit approximately matches their cost, they may be left out of our analysis. The **in-kind payments** should receive the same valuation: they replace private purchases, but the result is the same as if the farmers had purchased the inputs directly with cash.

Assume instead that (2) there is a net change in the use of agricultural inputs as a result of the project. Farmers use their **cash** payments to buy, say fertilizer, or they receive it **in-kind** directly from the project. In

both cases, the result is that the economy experiences an increase in the use of this commodity as a result of the project. Then we would like to find the opportunity cost of this resource, i.e. the cost of additional supply, to put against the benefit in terms of increased agricultural production.

In summary, the issue is not the form of payment, but rather the net impact on the economy as a whole. If we can observe that the consumption of a particular commodity increases as a result of the project, its costs should be weighed against the benefits.

For reasons explained previously in this chapter, there is reason to believe that the net use of fertilizer and hybrid seed is not significantly affected by the project. As for the inputs sold for cash by the project, these items are entered in the accounts as both a debit and a credit item, so with stocks being small, they balance out in the financial records. The inputs given out as in-kind payments are only used as a basis for the shadow pricing of labour, but are not valued separately as an input item.

Output Prices

Outputs from the project are crops (maize and sorghum), fruit, fuelwood and fodder. In an economic sense, residual capital (buildings and vehicles) are also outputs of the project, as they are left for the Lesotho economy to use after the FISC project is terminated, and if project activities are discontinued. However, this will not be assumed here. Therefore, the issue of pricing salvage values will not occur in this scenario.

Crop Prices

There is an important distinction to make between **white** and **yellow maize**. Basotho customers in general have a strong preference for white maize over yellow maize. From our crop sampling in the areas concerned, it is evident that almost exclusively white maize is cultivated. While there is a vast world market for yellow maize, the white maize market is thin and volatile. The RSA is the quite dominant supplier to Lesotho. Potential suppliers are Malawi and Zimbabwe in Africa and Thailand and the

People's Republic of China in Asia. As the RSA Maize Board tends to view Lesotho as a part of its domestic market, it is more economical for Lesotho to import maize via the RSA for its domestic selling price, as the Board would absorb any excess import price (Olsen, 1985). In addition, the RSA is likely to be the most efficient producer, and has the lowest transport costs for delivery to Lesotho.

The local market offers better prices than centralized purchasing points, and since relative increases in output are expected to maintain current production rather than increase it, it is likely to be absorbed by local demand. Hence, the local financial price will also be used in the economic calculations. This implies M 540 per ton of white maize and M 460 per ton of sorghum in 1990, in accordance with the discussion in section 5.2.2.

As for the **trend** in prices, these are subject to the uncertainties of political interference rather than the uncertainties of production levels and demand changes. This is not entirely unpredictable, as a political ambition of the regulated South African Market Board system is to provide price stabilization. It is therefore of some interest to look at the realized trend over time. Local price data are not available for any length of time. However, current white maize **millgate** prices (1976/77-1990/91) are available for Lesotho. These have been converted to real (1990) prices. A simple regression for white maize to uncover any time trend shows that:

$$P = -12176 + 6.33 * T$$

$$R^2 = 0.44$$

where

P = Price in 1990 Maloti per ton of white maize

T = year: 1977 ... 1991

The positive time coefficient represents an increase of almost 2 percent per year, as compared to the average of the dependent variable. The coefficient is significant on

the 1 percent level. A regression to uncover the time trend of the sorghum price shows that:

$$P = 16892 - 8.32 * T$$

$$R^2 = 0.45$$

where

P = Price in 1990 Maloti per ton of sorghum

T = year: 1977 ... 1987, 1990, 1991

The negative time coefficient is significant on the 5 percent level and represents an annual decline of approximately 2 percent of the dependent variable mean. It appears that prices for maize and sorghum have developed as "mirror images". If they continue to do so, the areas devoted to each crop are likely to adjust accordingly. This adjustment will have a stabilizing effect on prices. The simplified assumption of constant real prices and crop shares will be assumed in the base case. This is subject to sensitivity analysis below.

Regarding crop residues, Hahn (1990) has undertaken a comparison of the protein and energy content of maize residues as compared to five substitutes. On the basis of their prices, the approximate price of M 60 per ton of maize crop residues was derived. The same figure will be applied to sorghum residues.

Fruit Prices

There is little research on fruit markets in Lesotho, since it has never been a substantial income earner. Most fruit is imported from the RSA. There is virtually no experience of fruit growing and commercial sale in the project areas, and therefore no real empirical basis to speak of. As fruit trees mature, the monitoring of prices realized will be important to determine project performance. In view of this, price data are taken from a small survey made by the author in Mohale's Hoek in November 1990, and adjusted in accordance with discussion with project personnel.

Market prices for apples and apple size and quality were found to be rather uniform in Mohale's Hoek town. On the basis of five random samples of four apples each, the average price of M 1.7 per kg was determined. Domestically produced apples will not generally reach the same quality, as they are grown under different management, e.g. not utilizing pesticides. It is assumed here that the apple growing farmer realizes about half of this price, the rest being compensation for transport, retailing and quality adjustment. This will be subject to sensitivity testing, as the empirical basis is obviously weak.

In a similar fashion, peaches were bought and weighed. The supply of peaches is less stable than that for apples, and the prices therefore much more variable. Interviews with fruit vendors and project personnel lead to the assumption that the peak season entails a retail price of about M 0.05-0.1 per peach. The estimated weight of a peach is about 50 g, based on an average of the few peaches that were available at the time of the survey, giving a price per kg of M 1-2. For the same reasons as with apples, the average of this is adjusted downwards by 50 percent to arrive at the expected price for the grower (M 0.75). Again, this will be subject to sensitivity analysis.

As for the trend in fruit prices, we lack data on changes in real prices over time. The potential for increased supply to meet further demand is probably substantial, given good climatic conditions in the RSA and good availability of labour. Therefore, the assumption will be that real prices remain stable on the overall market. However, the local market may experience downward pressure if fruit growing continues to increase in popularity.

Fuelwood Prices

There is no substantial local market for fuelwood or substitutes in the project areas. The output from the only major domestic source, the nationwide Lesotho Woodlot Programme, is sold at politically determined prices which do not even cover the cost of production, as observed in the financial analysis.

However, since the fuelwood produced by the project will substitute local fuels such as brushwood, dung and crop residues, the economic value of fuelwood can still be determined. The substitutes have a value as fuel, fertilizer and animal feed respectively. One m^3 of fuelwood is assumed to yield an energy content of 8 800 Mega Joules (MJ) (CPDO, 1987). Knowing the calorific values of the substitutes, the weights in kg needed for substitution are arrived at. These are multiplied by the prices calculated by the Central Planning and Development Office (CPDO, 1987). Finally, the value is re-calculated into 1990 prices.

Table 5.16 Economic Value of Fuelwood Substitutes per m^3

	MJ/kg	Eq. kg	M/kg(1987)	M(1990)
Brushwood	16.0	550	0.03	24.33
Dung	12.9	682	0.10	100.61
Crop residues	14.0	629	0.02	18.54

Source: Adapted from CPDO (1987)

This reveals substantial differences that would imply that dung should be replaced first. However, dung is not available to non-cattle owners without arduous collection on the hillsides. If Maphutseng is representative of the entire project area in this respect, about half of the households do not own cattle (Dahlberg, 1987). Furthermore, even if cattle-owners could collect dung from their kraal, this is currently rarely used as fertilizer (Mashinini, 1988; Yaxley, 1987). There are also other aspects to fuel than the price: burning characteristics are important.

The distribution of harvested fuelwood is likely to be handled by administrative rationing at zero price through the Village Development Council rather than through a free market. The actual substitution value will vary depending on the household's situation. Animal owners may substitute some dung, whereas households without animals

(crop land owners and landless alike) may substitute brushwood, as this is more expensive than crop residues. A rough, weighted average could therefore be calculated as follows:

a) 25% will substitute dung	0.25 *	M 100.61
b) 75% will substitute brushwood	0.75 *	M 24.33
Weighted average:		M 43.40

As for the trend in real prices of fuelwood, they will be assumed to rise by 2 percent per year due to increasing shortages. Again, this is not based on any documented price trend.

Fodder Prices

Fodder prices are taken from Hahn's (1990) survey in the project area: M 0.36 per kg of Banagrass and M 0.12 per kg of Eragrostis. Since areas are about equal for the two grasses, the fodder price is averaged to M 0.24 per kg. As for the trend of the real fodder price, continued overgrazing and the desire to increase herds is likely to increase the scarcity of fodder. Therefore, a real price increase of 2 percent per year is assumed. This is not based on any documented price trend. As fodder is a small benefit item, the exact assumption on this point will not crucially influence the overall economic result.

5.3.5 Discounting

There is no tradition in Lesotho of using CBA within the administration, so there is no national, generally used social discount rate available. Nor does the donor have any guidelines as to the proper rate to use (SIDA, 1987a), as CBA is not consistently used to evaluate aid projects. It could be argued that SIDA is active on an international "donor's market", and that the return on its resources should be at a comparable level to alternative multi-lateral institutions' achievements. Therefore, an international comparison is interesting.

In chapter 4, it is shown that internationally, an informal, although by no means complete, convergence around a real rate of 10 percent exists for the

evaluation of soil conservation projects. This is also the rate commonly used by the World Bank for projects in general (Markandya and Pearce, 1988). This should be viewed against the evidence of ex post rates calculated from aid projects all over the world. The World Bank requires such rates to be calculated as a routine on virtually all projects. The cumulated results from the World Bank project audit results from the 1960s and 1970s were 17 percent on average for the two decades. Another review of over 1 000 projects completed in 1975-1983 showed that 79 percent achieved at least the 10 percent target rate. In fairness, it should be mentioned that projects in Africa are among the least profitable internationally, although agricultural projects have in general performed better than industrial. (Cassen, 1986).

The World Bank's experience in Lesotho has been less than fortunate, with the Thaba Bosiou project followed by the equally unfortunate Basic Agricultural Services Programme[10] (World Bank, 1987). It would thus be reasonable to regard the 10 percent rate as a high standard of achievement in the case of Lesotho, and it will be used as an upper bound standard here.

The author has made persistent efforts to obtain from the Lesotho National Development Corporation - the leading agency for industrial development - figures on rates of return on industrial projects in Lesotho. Some appraisals exist, belonging more to the realm of science-fiction than to economics, as their primary purpose is to obtain funding support. Attempts to evaluate the actual rates of return have unfortunately not provided any meaningful data.

What rates have analysts in fact used to calculate Net Present Values in Lesotho? The largest project ever to be undertaken in Lesotho - The Highlands Water Project - has been analyzed using 6 percent. However, this is calculated as the real cost of borrowing, and is not based on the opportunity cost concept, due to the uniqueness and size of the project (LHC and OSC, 1986). A major road study (Louis Berger International Inc., 1986) used 10 percent with reference to the Central Planning and Development Office. Our check of that reference

10. See chapter 3 for a background.

revealed the source to be the opinion of an economic adviser rather than an officially accepted rate.

Banking officials point to the excess liquidity of the Lesotho banking system and the long time prevailing negative or low positive real interest rates charged to borrowers. For the 1970s and 1980s, figures from the Central Bank of Lesotho (1986, 1990) show that this rate has been around 1 percent as an average. This is the rate the borrower needs to pay after tax. However, as discussed in chapter 3, the legal and illegal possibilities of avoiding tax are substantial, which makes the required return before tax not very much higher in general. Using this as guidance for the opportunity cost of resources used elsewhere in the economy, a lower bound real rate of interest of 1 percent will be used.

In summary, there is a lack of clear policy from the recipient government and donor alike as to what rate of return is acceptable. There is very little empirical evidence of ex-post rates of return from projects in Lesotho. A rate such as 1 percent, would appear sufficient to meet demands placed elsewhere in the economy on capital borrowers in the last two decades, and will be used as a lower bound discount rate. The commonly used 10 percent rate can be seen as an upper bound. As so much controversy is attached to the use of discount rates, both will be applied in the base case, and used throughout the sensitivity analysis.[11]

5.3.6 Time Horizon

The FISC Project may have long lasting effects on the agricultural production in the project area. The question here is: how long? This will depend on factors such as how successful the project package turns out to be in increasing yields of agricultural products, and how the local institutions and counterparts manage to shoulder their role, once the external project support has been withdrawn.

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11. Assuming that exchange rates adjust according to differences in inflation rates across countries, there is no need to adjust for exchange rate changes in order to calculate the required rate of return in different currencies. See Mellander (1989) for an alternative view.

Given the past, dismal, record of conservation maintenance in Lesotho (Nobe and Seckler, 1979; Chakela and Cantor, 1986), it is difficult to believe in a sudden change at this stage. Evidence from the first pilot project area in Maphutseng (Dahlberg, 1988) also illustrate poor local institutional strength. This is confirmed by data on farmer participation discussed below, and the author's interviews during recurrent field visits.

It can be noted for comparison that many other CBAs of conservation projects use a time horizon of 10-50 years, with 20 years being rather common, as shown in chapter 4. It is often argued that "a long term view" must be taken on conservation. This will be handled here by accounting for a 50-year period of time. This is supported by two considerations. First, if the project cannot prove its worth in the first 50 years of its existence, it is advisable to reconsider its implementation. Second, there is the **conditional** argument of the size of even more remote impacts. With a discount rate of 10 percent, a longer perspective would add little: one Maloti of net benefit in 51 years ahead is worth only 0.8 cents now. However, if 1 percent is considered a reasonable rate of discount, the argument is not valid; the same net benefit would amount to about 60 cents today.

5.3.7 Distributional Effects

Income distribution in Lesotho is quite skewed, as is discussed in chapter 3. It is clear from the donor's side that distributional aspects have been a concern behind the location of the project (SIDA, 1983). However, as shown in the table below, Mohale's Hoek District is not an extremely poor region as it ranks as no. six out of ten districts in terms of household income. From an income distribution perspective, aid projects in Qacha's Nek would be even more worthwhile. The income concept used here is "total income", i.e. cash plus in kind income (BoS, 1988b).

Table 5.17 Average Income by District (M/household/month)

District	Income
Maseru	301
Leribe	279
Berea	275
Butha-Buthe	245
Mafeteng	220
Mohale's Hoek	219
Quthing	204
Mokhotlong	185
Thaba Tseka	183
Qacha's Nek	180
Lesotho	248

Source: BoS (1988b).

Will the project improve income distribution in Lesotho? The answer will depend on how narrowly the interest is focused on the very poorest in society. What has been said above is based on district averages, because this is how available data happen to be grouped. However, there is also the individual (or household) aspect.

There is one in-depth study of project participation and income distribution in Maphutseng (Dahlberg, 1987). The findings indicate that non-participants are often younger, with smaller land-holdings, fewer animals and with the husband absent in the mines in South Africa. In general, non-participants were in an earlier stage of the household life cycle. In terms of **stated income**, there was no significant difference between participants and non-participants. However, miners' remittances were more important for non-participants, while participants to a larger degree relied on agricultural income (Dahlberg, 1987, pp. 1-2).

This confirms a plausible assumption; households with (a) labour resources and (b) a strong reliance on agricultural income will show greater interest in farming improvements. However, it should be remarked that household income is known to be a difficult area to survey in general, and subject to biased responses. In

particular, it appears reasonable to assume that households in Lesotho which do **not** rely on migrant remittances have difficulty in reaching the same level of income as others. If we assume that households receiving remittances have biased their income statements downward, this strengthens the distributional profile of the project.

A project aimed only at land-holding households would have left the landless out. However, FISC is working through village institutions and has engaged many landless in works on communal land for cash payments. There is strong evidence from interviews that primarily women have benefited from the labour opportunities available, since many male workers are simply absent. Dahlberg (1987) reports that some women complain about the physically heavy work. With development of other income generating activities such as planting of fuelwood trees, fruit trees and cultivation of vegetables, this complaint could perhaps be addressed.

A further aspect related to income distribution is that the project has encouraged communal harvesting of hay in the afforested grazing area under the guidance of the Village Conservation Committee. The grass would then be sold to animal owners. However, this scheme is in deadlock after much controversy. Livestock owners have objected to "paying for something which is free". About half of the households do not own any livestock at all, and would therefore potentially benefit from such a scheme. The handling of the so called "communal" grazing land, which today actually benefits a relatively well-to-do minority will be a test of the project's distributional consequences.

The long term inequality in land distribution is something the project cannot realistically be expected to affect. However, it may be able to affect communal management of grazing land. The idea of marketable grazing rights mentioned in chapter 3 has been promoted by the FISC Project, but so far without any implementation. The idea has been presented to public meetings in five villages. Four greeted the idea favourably (Mashinini et al, 1988). However, it is impossible to judge how representative of the villagers these meetings are. As general, public meetings

("pitsos") they do not carry any legal force. It remains to be seen what reception this proposal will receive from the Government of Lesotho and SIDA. From an equity point of view, the idea is certainly attractive.[12]

5.3.8 Base Case Results and Sensitivity Analysis[13]

Given the assumptions stated above on project performance, the results of the base case are as follows:

Table 5.18 Base Case Results for the FISC Project

	M Million
NPV (r = 1%)	- 5.6
NPV (r = 10%)	- 7.0
IRR (%)	- 0.8

The qualitative interpretation is that the project makes a loss that is significant in comparison to the resources invested. The present value of economic costs[14] is M 33.6 million with the lower rate of discount but only M 9.9 million with the higher rate. Returns are not sufficient to meet even the lower of the targeted rates. The table below summarizes the benefit categories, which provides some overview of the relative importance of various benefit items. Each benefit category has been discounted with 1 and 10 percent respectively.

12. This point is not discussed further here, but see Bojö (forthcoming).
13. The results are based on a considerable number of tables not included here. They are all available upon request to the author.
14. Note that all economic costs over the 50- year time span are considered here, not only the costs accruing to the donor during 1985-1992.

Table 5.19 Discounted Shares of Total Benefit

Item	Benefit shares (1%)	(10%)
Sorghum(CCB)	30	25
Maize (CCB)	28	23
Fruit	29	38
Fuelwood	11	12
Fodder	1	2
Total	100	100

While maize gives more crop conservation benefits in terms of grain production, sorghum produces larger quantities of residue which more than compensates for the lower unit price of the grain. The table also shows that fruit is a significant benefit item that deserves more thorough monitoring in the future. So far, there has been little empirical evidence available on this point. This, and conservation benefits, make up the bulk of benefits, and deserve closer scrutiny in terms of sensitivity testing. As for the differences between the columns of the table above, crop conservation benefits will be relatively more significant when using a lower rate of discount as they are slow to materialize.

Sensitivity Analysis

The robustness of this base case result will now be tested. Major uncertainties concern:

(1) appropriate discount rate
(2) post-1992 project performance
(3) fruit income
(4) erosion impact on crop yields
(5) future grain prices
(6) appropriate distributional weights

The first point has already been included in the presentation of the base case results. The alternative rates will be carried through when testing for other alternative assumptions. Points 2-6 are tested below.

Post-1992 Project Performance

In the base case, a general level of benefit performance of the project after discontinuation of external funding was assumed to be 50 percent of the average for previous years. On the cost side, the items related to expatriate participation were eliminated as of mid-1992, implying a cost level of 54 percent of the average over the previous years of donor involvement. Obviously, actual performance could be both better and worse than in the base case. If performance is worse, the result of the base case is further strengthened. It is more interesting to look at the impact of better performance, to target the achievement rate necessary to reach an acceptable economic return. It is therefore assumed that post-1992 project benefit production comes up to 80 percent of the previous average level. The results are shown below.

Table 5.20 Post Project Performance (M Mill.)

Benefit Rate (%)	NPV (1%)	NPV (10%)
Base Case (50)	- 5.6	- 7.0
(80)	6.0	- 6.2

The IRR becomes + 2.3 percent which exceeds the lower target rate discussed here. If the donor and the Government of Lesotho believe in this or even more optimistic scenarios than the one presented here, and if this rate of return is considered acceptable, it appears reasonable to discontinue funding to the project in Mohale's Hoek and let the domestic personnel continue the work. If the more pessimistic scenario base case is taken as more probable, the question is whether additional external funding would improve the forecast enough to outweigh the additional expense. Various options could easily be incorporated into the calculations.

Fruit Income

In our base case a considerable part of the discounted benefits are derived from fruit trees. The assumptions that are made on this point are therefore essential for

the outcome of the calculation. It could be argued that it is unduly pessimistic to assume that farmers in the project area will only reach a production and quality level of 50 percent of what advanced management could achieve (Snir and Holland, 1986). Furthermore, we have assumed that the price realized by the grower is only 50 percent of the retail price in Mohale's Hoek town. Assumptions regarding quantity and price could both be changed, but we limit the presentation here to one of adjusting the income upward by 100 percent. This could be the result of better quality, or higher quantity per tree, or a larger share of the retail price accruing to the producers, or any mixture of these factors.

Table 5.21 Higher Fruit Income (M Mill.)

Fruit Income	NPV (1%)	NPV (10%)
Base Case	- 5.6	- 7.0
+100%	2.6	- 5.9

The IRR is slightly positive at 1.7 percent. Thus, a very considerable increase in fruit income could bring the result up to a level that might appear acceptable. However, it should be remembered that this scenario is extremely optimistic as to the level of fruit income. Quality, yield and marketing would all have to reach impressive standards for this to be realized.

Yield Patterns

In the base case, the assumption is made that crop yield without soil conservation would decline 1 percent per year as a result of continuous erosion. It is possible, although not very likely, that this is an underestimate. If it is an overestimate, changing this assumption would only strengthen the base case result, and this alternative will therefore not be illustrated numerically. This variable is tested by assuming a decline of decrease of 3 percent per year in the "without conservation" alternative.

Table 5.22 Soil Loss - Yield Impacts (M Mill.)

Yield decline (%/yr)	NPV (1%)	NPV (10%)
Base Case (1%)	- 5.6	- 7.0
(3%)	14.7	- 5.0

The IRR here is + 4.1 percent. Given the 10 percent rate of discount, even a rather dramatic decline in yield due to erosion would not make the project economically viable. However, if the lower rate is considered acceptable, the more drastic rate of erosion would improve performance considerably. It must be reiterated that 3 percent annual decline appears less plausible than the base case rate of 1 percent, which may even be an overestimate of the actual value.

Future Grain Prices

The markets for white maize and sorghum are subject not only to the vagaries of climate and resulting instability of supply, but also to the political determination of prices. The latter is probably stabilizing, but could of course change with a change of government in the RSA, and under pressure from changes on the world market. Further liberalization of agricultural policies in the West may stop excess dumping of substitute grain on the world market. This may raise real prices in the future. To test for this assumption, a scenario with a 2 percent annual increase in the real price of both white maize and sorghum, starting in 1991 is tested. This implies a very considerable increase in prices of 139 percent at the end of the period considered here. Results are shown below.

Table 5.23 Higher Real Grain Prices Scenario

Grain Price Increase (%/yr)	NPV (1%)	NPV (10%)
Base Case (0%)	- 5.6	- 7.0
(2%)	4.6	- 6.5

The IRR is raised to +2.0 percent in this scenario of considerably increasing grain prices. As a single change

in the assumptions, it is not very powerful if the higher discount rate is used, but it does make a difference at the lower rate.

Distributional Weights

It has been argued that economic inefficiency is not important in the case of soil and water conservation: "what if a few million dollars are lost - we are talking about poor farmers!" If the project cannot be justified on grounds of raising the production in the area, but rather as a means of transferring income from tax payers in Sweden to Basotho farmers, then we are still left with two questions. Firstly, if the project is basically an income transfer rather than a production project, are there perhaps less costly ways of handing out the money? This question is not answered here, but ought to be considered by the responsible decision-makers. Secondly, how much more does one have to weigh the benefit of a Basotho farmer rather than a tax payer in Sweden in order to justify this transfer? This is shown here. Whatever weights are used, they need to be consistently applied across all project options.

It has not been possible to identify the benefit allocation among groups in Lesotho in closer detail than discussed in the previous section on distributional impacts. Therefore, the entire benefit stream is weighted to arrive at the break-even weight which will make the NPV turn positive.

Table 5.24 Distributional Weights (M Mill.)

Distributional weight	NPV (1%)	NPV (10%)
Base Case (1.0)	- 5.6	- 7.0
(2.5)	0.0	
(*.*)		0.0

The size of the weight depends crucially on the discount rate used: one must weigh the benefit of the recipients with a factor of at least 2.5 at the 1 percent discount rate to achieve an NPV close to 0. However, if 10 percent is used as a rate of discount, an interesting point

emerges. Given the assumption that domestic funding takes over after 1992, there is simply no feasible distribution weight that can achieve such a high rate of return.[15] The logical options are (1) that SIDA must continue to fund the project after 1992 even in spite of the dubious efficiency, or (2) all project efforts, **foreign and domestic**, should cease immediately after 1992. In other words, the project is only sustainable as a channel of foreign funds, not as a domestically sustainable activity - if the higher rate of return is the target.

Summary of Sensitivity Analysis

Given a discount rate of 10 percent, the discouraging results about the project's low profitability are robust. Assumptions within reasonable ranges regarding key variables do not greatly affect this qualitative result although it changes the value of the loss. This is altered if the lower rate of 1 percent is considered an acceptable norm. Setting the standard this low would seem modest, given the official ambition of Swedish aid to contribute to "economic growth" (SIDA, 1987a) and the performance of other aid projects around the world (Cassen, 1986). However, the experience of other agricultural aid projects in Lesotho is rather dismal, so if the choice of project is dictated by a political preference for this sector, and for the country of Lesotho, the alternatives may be even worse. The project could of course quote the powerful impact of the distributional weights. However, this raises additional questions: What if the same income distribution weights are applied to other projects?

5.3.9 Policy Implications

The project has not demonstrated success in relation to the overriding goal stipulated by SIDA (1983) and shared by the Lesotho Government- to increase the production on small scale farming units - **when this increase in production is put in relation to the cost of the project.** The FISC project uses simple, labour-intensive

15. The weight is applied also to domestic costs, thus counterbalancing the benefits and restraining the maximum achievable return.

techniques. It is based on consultation and people's participation. It therefore has several positive features associated with a successful conservation project - and is generally regarded to be so by observers. The project has a competent and devoted leadership. Therefore, the outcome of this analysis is contrary to many expectations. The low performance is not due to project specific factors of negligent management and the like, which would have made it easier to draw conclusions on management improvements. Explanations are rather to be found in the very difficult environment of low expected returns to agricultural investments, coupled with high risk exposure and low incomes among farmers.

Even if distributional concerns are taken to provide the main rationale for the project, it is still justified to search for more efficient ways of achieving the same kind of positive impact on poor rural households. If income distribution weights are applied in this case, they must be consistently applied to all alternative projects as well.

Although FISC is "low-cost" in terms of field technology, it is not a low-cost project in terms of personnel. The component concerning skilled personnel, including qualified back-up from Sweden and short term consultants recruited internationally, amounts to about 46 percent of current economic cost for the 1985-1992 project period. This has made the cost per hectare reached by conservation high. One way to reduce this cost is to expand the area of operations for the central expatriate staff. This began to take place as of early 1991, and is a development to be welcomed. It points to the need for more active sharing of responsibility on the part of Lesotho personnel. This concerns the entire hierarchy from the top down to the local farmers.

Immediate improvements in project performance could be achieved if greater extent of "high input" management were achieved. The project needs to demonstrate tangible benefits from this alternative and to effectively communicate crop results back to the villages. Continued crop sampling as carried out as a part of this research is one component of this task. However, exogenous constraints on increased output are severe in Lesotho, and the results so far are not encouraging.

The project needs to improve its collection of project performance indicators to enhance the possibility of evaluation. Primarily, this concerns fruit production, as this emerges as a very important benefit item.

Finally, the result has implications for the replication of this project. This is only viable economically if the degree of expatriate involvement is much lower than in the original FISC Project area.

5.4 Summary and Conclusions

This chapter starts by reviewing differences between the financial and the economic perspective, and it is concluded that they differ on a number of points. The choice of the Farm Improvement with Soil Conservation (FISC) project as an object of study is justified by its features coinciding with the modern approach to deal with land degradation: production orientation, labour intensive techniques and popular participation. Furthermore, low-cost access to information could be assured from a research point of view. The project area is fairly typical for Lowland Lesotho, where most of the crop production takes place. With some adjustments, the calculations could be used for other areas in Lesotho, or even for other areas with similar geographic and socio-economic features in other countries.

The overriding aim of the FISC project is to raise agricultural production. In pursuit of this goal, the project has rehabilitated old terrace structures, constructed new ones and added other structures for conservation. It has promoted hybrid maize and sorghum, fodder grasses and planted thousands of tree seedlings. It has also promoted rotational grazing on communal rangeland.

The FISC project was initiated in 1985 in Mohale's Hoek District in southern Lesotho, and is gradually being expanded. The author has been in close contact with the project since its inception. Current project plans extend to mid-1992. The project is now used as a model for a national training programme in soil conservation. Other soil conservation projects are already using FISC as a model. This underlines the importance of seriously studying the experience of FISC.

The Financial Analysis

The financial analysis is done from a household perspective, using market prices. Two management options for cultivation of maize and sorghum have been compared in financial terms. The "high input" alternative implies the use of commercial fertilizer and hybrid seed. The "traditional" alternative implies no use of fertilizer

and locally saved seeds instead of hybrids. The less immediate impact of soil conservation measures is left out of this calculation, which is valid for one year only.

Crop sampling has been carried out in cooperation with the FISC staff during five seasons (1986-1990) as a part of the research reported on in this chapter. The results show that farmers using a "high input" management do receive higher yields on average, but that very substantial variations of yields make this a risky investment.

Financial calculations for maize and sorghum show the demand for yield raises, in order to achieve a real rate of return of 10 percent. The demands are significantly higher than the average achieved under high input management as sampled, which give a **negative** real marginal IRR of 21 and 30 percent respectively.

Maintained participation in the project appears limited after the initial boost when conservation efforts result in in-kind payments. Most likely, project sales are merely replacing alternative, less accessible sources of supply. There are no convincing signs of a major transformation of the crop management regime. The long-term impact of physical conservation works may be the only net impact, as far as the major grain crops are concerned. However, financial budgets for fruit and fuelwood trees show more promising returns, and have also met with greater interest among local people.

Possible explanations for the lack of farmer response to the promotion of "high input" management are discussed in chapter 3, which gives a macro-economic framework for the micro-level study in this chapter. The discussion concerns, inter alia, land tenure, credit for agricultural investments and risk pertaining to agricultural investments. This discussion will not be repeated here, but a brief comment is in order to recapitulate the main points.

While the problem of communal access, degrading into open-access, is a major one for **rangeland**, it does not appear to be a major factor to consider for **crop land** in Lesotho. Access to credit is limited, but the cash flow

from miners remittances is considerable, and borrowing rates reasonable. While access to credit could be improved, it is unlikely to be a major obstacle in the face of genuine financial opportunities. More serious is the problem of risk. Crop yields are very unreliable in Lesotho. The farmers are quite aware of this and will (informally) calculate the chances of losing invested resources. Demands for yield increases for maize and sorghum have been shown to be considerable in order to reach an "acceptable" level of financial return (10 percent real rate). It is certainly not "irrational" of the farmer to adopt a careful approach in the face of these risks.

The Economic Analysis

Overall project performance has been recorded for the period March 1985 to December 1990. Current, firm plans for work until mid-1992 have been incorporated, and extrapolations have been made from past performance in relation to the availability of future financial means. As for the period after 1992, the following assumptions - the reasons for which are explained above - have been made:

As for **costs**, it is assumed that domestic authorities try to uphold the services provided by the project, using buildings, vehicles and other resources left behind by the project. The level of costs is assumed to remain as the average for 1985-1992, but with all costs associated with expatriate (non-domestic) services, such as consultant fees, back-stopping by the executing company, external evaluation missions etc. taken out. This implies a level of 54 percent of the previous average.[1]

As for benefits, it is assumed that the project continues to add newly conserved crop land at a performance rate of 50 percent of the previous level. However, from the accumulated area under conservation management reached the previous year, a decline rate of 2 percent per year is applied. Another assumption is that there will be no lasting impact on the level of use of fertilizer and hybrid seed. Furthermore, it is assumed that distribution

1. The years 1985 and 1992 are counted as half years as the project started into 1985 and is scheduled to finish by the middle of 1992.

of fruit trees continues, but declines to a level of 50 percent of project maximum. For fuelwood it is assumed that tree planting declines to a level of 50 percent of project average achievement in 1986-1991. For fodder grasses, the assumption in the base case will be that fodder growing stabilizes on 50 percent of the level achieved in 1986-1991. Given these assumptions, the results of the base case are an NPV of - M 7.0 million at a discount rate of 10 percent and - M 5.6 million at 1 percent.

The qualitative interpretation is that the project makes a loss that is significant in comparison to the resources invested. The present value of costs only is M 9.9 million at 10 percent and M 33.6 million at 1 percent. In terms of the overriding target for the project as defined by the donor - to raise agricultural production among smallholder farming households - the project cannot be shown to be successful, when the benefits are related to the costs. It is important to note that this cannot simply be attributed to poor management of this particular project, in which case the policy implication would be clearcut.

The robustness of this base case result is tested using sensitivity analysis of alternative assumptions with regard to:

(1) discount rate
(2) post-1992 project performance
(3) fruit income
(4) erosion impact on crop yields
(5) future grain prices
(6) distributional weights

The qualitative impression of the sensitivity analysis is that, if the rate of 10 percent is used, the base case result remains robust, although the size of the deficit is changed. Distributional weights could possibly justify either continued donor funding in spite of poor efficiency, or the complete dismantling of all activities, but not a continuation of the project under domestic funding.

However, if the lower rate of 1 percent is considered acceptable as a standard, the base case result could be

qualitatively altered by several factors making the project perform better than expected. With the lower rate, the project could also be justified using a heavy distributional weight reflecting the higher marginal utilities of the recipients as a group as opposed to the donors as group. However, this weight should then be consistently applied to alternative projects.

One should not forget the notes about **intangibles** made along the way:

(1) Secondary community benefits due to increased spending are probably very limited locally. Most of this will leak out to the Republic of South Africa, and constitute a cost to the donor rather than a benefit.

(2) It should be recalled from the section on quantification of costs that the labour requirement for maintenance of conservation structures was omitted. However, if the higher cost estimate (Michael Stocking's) is accepted, the size of conservation benefits change drastically. It can be shown that the break-even point for maize is 15 person-days, given a time horizon of 50 years and a discount rate of 10 percent. This labour requirement coincides with Stocking's estimate. Given a discount rate of 1 percent, the maximum labour input is raised to 34 days, before the net present value of conservation benefits approximate zero. Thus, it is possible that this benefit item has been considerably overestimated. Only empirical measurement in project areas could resolve this issue.

(3) Recently the "FISC model" has been placed at the centre of national conservation training, with the transfer of the previous FISC Team Leader in a position as a national adviser on conservation training. Both SIDA and Swedforest personnel view this as the major chance for the experience gained in Mohale's Hoek to bear fruit.

It can be objected that the elements of FISC are not really new. As discussed in chapter 3, the history of soil conservation projects in Lesotho is long, the promotion of fertilizer and hybrid seeds is a well established practice within agricultural policy, and promotion of fuelwood trees has a long-standing record in the country. Attempts to promote fruit trees and fodder

grasses have also occurred previously. What is probably more novel is the emphasis on training of local people and of institution building, which is an important feature of the project.

(4) An additional point is option value. As discussed in chapter 3, Lesotho is extremely dependent upon migrant labour remittances. The high price scenario is designed to build into the calculation the possibility of a substantial increase in relative prices, as a proxy for the somewhat unlikely, but not impossible event, that a mass of migrant workers are forced to return to Lesotho. While the nominal price level in fact may not be changed considerably due to the extent of the market, the real price would increase for Basotho, as incomes would fall. The value of the project is thus correlated to the size of the GNP of Lesotho. From both a macro and a micro perspective, the soil conservation programme is an "insurance" against hard times. This leaves the decision-makers with a partially quantified problem: is the present value of the options higher than the negative NPV of the stream of costs and benefits that have been valued?

However, soil conservation is not the only possible "insurance" against declines in migrant labour incomes. Lesotho needs **food security**, not necessarily more domestic production of grain. If an economic capacity to buy grain on the world market can be established through other development projects, this may be a more efficient alternative. Lesotho has a comparative advantage in inexpensive labour, not in good agricultural land and a beneficial climate. Screening available options for development project for their profitability is therefore a useful exercise. Furthermore, the capacity to ensure food security is dependent on the **size** of the population, a neglected matter which needs urgent attention in Lesotho.

While non-agricultural investments may be more efficient from a macro economic point of view, the majority of the population, and the poorest part, live in the rural areas. If the primary value of a project like FISC is not so much immediate production raising, but to a significant degree long-term protection of the land base, there could be a basis for more substantial subsidizing

of cover crops such as fodder grasses at the expense of traditional cropping. Even if fodder could not be commercially sold, the grower would provide an "insurance service" while protecting the land for future, potential need. The economics of this option need to be worked out.

This study cannot conclusively provide an answer to the future value of the FISC approach, but has given some reason why massive, full-scale replication involving a substantial number of expatriate personnel should be avoided. Continued efforts should be subject to close monitoring of their efficiency in order to justify any further funding.

REFERENCES

Anderson, D., 1987: The Economics of Afforestation. A Case Study in Africa. The World Bank. Occasional Paper Number 1/New Series. Washington, D.C.

Bojö, J., 1986: An Introduction to Cost-Benefit Analysis of Soil and Water Conservation Projects. Report no. 6 from the SADCC Coordination Unit for Soil & Water Conservation and Land Utilization. Maseru, Lesotho.

Bojö, J., 1989a: "Case Study: Benefit-Cost Analysis of Soil Conservation in Maphutseng, Lesotho" pp. 250-288 in Dixon, J.A., James, D.E. and Sherman, P.B. (eds.), The Economics of Dryland Management. Earthscan. London.

Bojö, J. 1989b: Cost-Benefit Analysis of Soil and Water Conservation Projects. A Review of 20 Empirical Studies. Paper presented to the 6th International Soil Conservation Conference. Kenya and Ethiopia, 6-18 November 1989. Stockholm School of Economics. Stockholm.

Bojö, J., 1989c: Determining the Quantitative Impact of Farm Improvement and Soil Conservation Measures as a Basis for Cost-Benefit Analysis. An Example from Lesotho. EFI Research Paper 6397. Stockholm School of Economics. Stockholm.

Bojö, J., 1990a: "Cost-Benefit Analysis of the Farm Improvement with Soil Conservation Project in Maphutseng, Mohale's Hoek District, Lesotho", in Dixon, J.A., James, D.E. and Sherman, P.B. (eds.), Dryland Management: Economic Case Studies. Earthscan. London.

Bojö, J., 1990b: Economic Analysis of Agricultural Development Projects. A Case Study from Lesotho. EFI Research Report. Stockholm School of Economics. Stockholm.

Bojö, J., (forthcoming): Marketable Grazing Permits - the Solution to Overstocking of Rangelands? EFI Research Paper. Stockholm School of Economics. Stockholm.

Bojö, J., Pettersson K. and Shone, G., 1987: Crop Sampling in the Maphutseng and Brakfontein Areas. SADCC Coordination Unit for Soil and Water Conservation, Institute of Land Use Planning and FISC. Maseru, Lesotho. Mimeo.

Bojö, J. and Shone, G., 1987: Crop Sampling in the Maphutseng and Morifi Areas. SADCC Coordination Unit for Soil and Water Conservation and FISC. Maseru, Lesotho. Mimeo.

Bojö, J. and Shone, G., 1988: Crop Sampling in the Maphutseng and Morifi Areas. SADCC Coordination Unit for

Soil and Water Conservation and FISC. Maseru, Lesotho. Mimeo.

Bojö, J., Mashinini, V., Mokhothu, M. and Rydgren, B., 1988: Interdisciplinary Analysis of Soil and Water Conservation Projects. A report to SAREC. Stockholm School of Economics. Stockholm.

Bojö, J., Mäler, K-G. and Unemo, L., 1990: Environment and Development: An Economic Approach. Kluwer Academic Publishers. Dordrecht, The Netherlands.

Bojö, J. and Shone, G., 1991: Crop Production and the Use of Fertilizer and Hybrid Seeds: A Statistical Analysis from Lesotho. EFI Research Paper 6445. Stockholm School of Economics. Stockholm.

BoS (Bureau of Statistics), 1986: Lesotho Agricultural Situation Report. Maseru, Lesotho.

BoS, 1987: Statistical Yearbook 1987. Maseru, Lesotho.

BoS, 1988a: Incomes, Expenditure and Consumption of Basotho Households. Main Report for the Household Budget Survey 1986/87. Maseru, Lesotho.

BoS, 1988b: Incomes, Expenditure and Consumption of Basotho Households. Tabulation Report. Maseru, Lesotho.

Carvalho, J. and Holland, D., 1983: 1983 Crop Enterprise Budgets: Tree Fruits and Asparagus. Research Division, Ministry of Agriculture. Maseru, Lesotho.

Cassen, R. & Associates, 1986: Does Aid Work. Report to an Intergovernmental Task Force. Clarendon Press. Oxford.

Cauley, P.M., 1986: Benchmark Soils of Lesotho - Their Classification, Interpretation, Use and Management. Office of Soil Survey, Conservation Division, Ministry of Agriculture, Maseru, Lesotho.

Central Bank of Lesotho, 1986: Quarterly Review. September. Maseru.

Central Bank of Lesotho, 1990: Annual Report 1989. Maseru, Lesotho.

Chakela, Q. and Cantor, J., 1986: History of Soil Conservation and Soil Conservation Policy in Lesotho. A report to the SADCC Coordination Unit. Maseru, Lesotho.

Chakela, Q., Lundén, B. and Strömquist, L. (eds.), 1986: Sediment Sources, Sediment Residence Time and Sediment Transfer - Case Studies of Soil Erosion in the Lesotho Lowlands. Uppsala University. Uppsala, Sweden.

Chakela, Q., Molapo, J. and Putsoane, T.G, 1989: Erosion Hazard Mapping of the SADCC Region. Part 3. Lesotho.

SADCC Soil and Water Conservation and Land Utilization Sector Coordination Unit. Maseru, Lesotho.

CPDO (Central Planning and Development Office), 1982: Financial Assistance for Labour Intensive Soil Conservation Project. Maseru, Lesotho.

CPDO, 1987: Fuelwood and Poles Forestry Sub-Project: Economic Analysis. Maseru, Lesotho.

Crosson, P.R. with Stout, A.T., 1983: Productivity Effects of Cropland Erosion in the United States. Resources for the Future. Washington, D.C.

Dahlberg, A., 1987: The Differential Impact of a Soil Conservation Project on Households & Women in Rural Lesotho. A Case Study of the Farm Improvement with Soil Conservation Project in Maphutseng, Mohale's Hoek District. Swedforest Consulting AB and SIDA. Stockholm.

Dahlberg, A., 1988: Local Institutions and their Role in Soil Conservation. A Case Study in Maphutseng, Mohale's Hoek District, Lesotho. Working Paper 65. Swedish University of Agricultural Sciences. Uppsala, Sweden.

DLUP (District Land Use Planner), 1985: Proposed Land Use Plan for Maphutseng Watershed. Institute of Land Use Planning. Maseru, Lesotho.

Ellis, F., 1988: Peasant Economics. Farm Households and Agrarian Development. Wye Studies in Agricultural and Rural Development. Cambridge University Press. Cambridge.

FAO, 1985: Commodity Review and Outlook 1984-85. FAO. Rome.

FISC (Farm Improvement with Soil Conservation) 1985-1990: Monthly Reports. Mohale's Hoek, Lesotho.

FISC, 1991: Annual Progress Report. Draft. Ministry of Agriculture. Mohale's Hoek, Lesotho.

Gay, J., 1984: "Basotho Attitudes to Erosion and Conservation", in Schmitz, G. (ed.), Lesotho - Environment and Management. Vol. I. National University of Lesotho. Roma, Lesotho.

Gebregziabher, T., 1989: Improvement of Natural Pastures Communally Owned and Managed by Villages in the Maphutseng Region. Swedish University of Agricultural Sciences. International Rural Development Centre. Working Paper 121. Uppsala.

Gittinger, J.P., 1982: Economic Analysis of Agricultural Projects. 2nd ed. Johns Hopkins University Press. Baltimore and London.

Grainger, A., 1990: The Threatening Desert. Controlling Desertification. Earthscan. London.

Hahn, T., 1990: A Financial Analysis of Fodder Production and Feeding of Sheep and Goats. A Case Study from Mohale's Hoek District, Lesotho. Swedish University of Agricultural Sciences International Rural Development Centre. Working Paper 142. Uppsala, Sweden.

Holland, D., 1983: Economic Differentiation and Agricultural Commercialization in Three Rural Areas of Lesotho. Research Division, Ministry of Agriculture. Maseru, Lesotho.

Holland, D. & Ts'iu, M., 1983: 1982/83 Crop Enterprise Budgets: Traditional and Improved Production Practices. Research Division, Ministry of Agriculture. Maseru, Lesotho.

Hurni H., 1985: Erosion - Productivity - Conservation Systems in Ethiopia. Paper presented for the IV International Conference on Soil Conservation, November 3-9, 1985, Maracay, Venezuela. University of Bern, Switzerland.

IFAD, 1986: Appraisal Report, Lesotho Local Initiatives Support Project. Report No. 0026-LE. International Fund for Agricultural Development. Rome.

IMF, 1990: International Financial Statistics Yearbook 1990. Washington, D.C.

Institute of Land Use Planning, 1986: Maphutseng Community Land Use Plan. Maseru, Lesotho.

Kizilyalli, H., 1982: Options for the Lesotho Economy in the Year 2000: Perspective Plan Alternatives. CPDO. Maseru, Lesotho.

Klosterman, E.W., 1983: For Discussion: A Suggested Solution to Lesotho's Overgrazing Problem. Research Division. Ministry of Agriculture. Maseru, Lesotho.

KI (Konjunkturinstitutet), 1991: Pressmeddelande 1991-03-27. Stockholm.

Lal, R., 1981: "Soil Erosion Problems on Alfisols in Western Nigeria, VI. Effects of Erosion on Experimental Plots.", pp. 215-230 in Geoderma. Vol 25.

Lesotho Today. Weekly newspaper. Maseru, Lesotho.

LHC & OSC (Lahmeyer MacDonald Consortium & Olivier Shoud Consortium), 1986: Lesotho Highlands Water Project. Feasibility Study. Supporting Report J. Economic and Financial Analysis. Ministry of Water, Energy and Mining. Maseru, Lesotho.

LHDA (Lesotho Highlands Development Authority) 1990, LHWP Rural Development Plan. Phase 1A. Volume 1. Summary. Maseru, Lesotho.

Lockeretz, W., 1981. "Crop Residues for Energy: Comparative Costs and Benefits for the Farmer, the Energy Facility, and the Public", pp. 71-89 in Energy in Agriculture. No. 1 1981/82. Elsevier Scientific Publishing Company. Amsterdam, The Netherlands.

Louis Berger International Inc. and Lesotho Consulting Engineers (Pty) Ltd., 1986: Feasibility and Engineering Study. Feeder Road Network. Final Report. Vol. I.

Lundahl, M. and Petersson L., (forthcoming): The Dependent Economy: Lesotho and the Southern African Customs Union. Westview Press. Boulder, San Francisco and London.

Lyles, L., 1975: "Possible Effects of Wind Erosion on Soil Productivity", pp. 279-283 in Journal of Soil and Water Conservation. November-December 1975.

Majoro, M. and Holland, D., 1986: Labour Use, Land Productivity, and the Effectiveness of Improved Technology in the Farming Systems Prototype Areas: 1982/83 Cropping Season. Research Division. Ministry of Agriculture. Maseru. Lesotho.

Markandya, A. and Pearce, D., 1988: Environmental Considerations and the Choice of the Discount Rate in Developing Countries. Environment Department Working Paper No. 3. World Bank. Washington, D.C.

Mashinini, V., 1988: Soil and Water Conservation in Maphutseng, Mohale's Hoek, Lesotho. National University of Lesotho. Department of Geography. Roma, Lesotho.

Mashinini, V., 1989: Land Tenure, Land-Use and Conservation in Maphutseng, Mohale's Hoek, Lesotho. National University of Lesotho. Department of Geography. Roma, Lesotho.

Mashinini, V., Shone, G. and Mokau, T., 1989: The Role of Community in Agricultural Development. Draft mimeo. DAO. Mohale's Hoek, Lesotho.

Matsaba, T.G.K., 1985: A Case for Fuelwood Production in the Kingdom of Lesotho. Department of Forestry and Wood Science, University College of North Wales, Bangor. Gwynedd, U.K.

Mellander, A., 1989: Cost-Benefit Analysis & Soil and Water Conservation Projects. A Minor Field Study. Stockholm School of Economics. Stockholm.

MoA (Ministry of Agriculture, Cooperatives and Marketing), 1981: Soil Erosion and Crop Production in

Lesotho. Engineering Section, Conservation Division. Maseru, Lesotho.

Modiani, P., 1986: The Shadow Wage Rate (SWR) in Lesotho Mimeo. CPDO. Maseru, Lesotho.

MoP (Ministry of Planning, Economic and Manpower Development), 1987: Fourth Five-Year Development Plan (1985/86-1990/91 Fiscal Years). Vol. 1. Maseru, Lesotho.

Nobe, K.C., and Seckler, D. W., 1979: An Economic and Policy Analysis of Soil-Water Problems in the Kingdom of Lesotho. LASA Report no. 3. Ministry of Agriculture and Department of Economics, Colorado State University.

Olofsson, P.O., 1990: Crop Sampling in the Farm Improvement with Soil Conservation Project in Lesotho. Report from a Consultancy February 5-22, 1990. SCB, Statistics Sweden and Swedforest Consulting AB. Stockholm, Sweden.

Olson, R.E., 1985: Marketing Patterns and Long Term Demand for Maize Meal in Lesotho. Ministry of Agriculture & Marketing. Washington, D.C.

Palin, D., 1983: Farm Improvement with Soil Conservation in Lesotho. Report to SIDA Mission. Swedforest Consulting AB. Danderyd, Sweden.

Pim, A.W. 1935: Financial and Economic Position of Basutoland. Report of the Commission Appointed by the Secretary of State for Dominion Affairs. His Majesty's Stationery Office. London.

Plath, J. 1982: 1980/81 Crop Enterprise Budgets: Traditional Production Practices. Research Division, Ministry of Agriculture. Maseru, Lesotho.

Reynolds, N., 1988: Communal Land Management. A Study for the Project on Farm Improvement with Soil Conservation. Swedforest Consulting AB. A report for the Government of Lesotho, assisted by SIDA. Danderyd, Sweden.

RRV, 1988: Lär sig SIDA? En granskning av SIDAs förmåga att lära sig av erfarenheterna. Revisionsrapport 1988-11-09. Stockholm.

Rydgren, B., 1986: "Soil Erosion in the Maphutseng and Ha Thabo Soil Conservation Areas", in Chakela Q., Lundén, B. and Strömquist, L. (eds.), Sediment Sources, Sediment Residence Time and Sediment Transfer - Case Studies of Soil Erosion in the Lesotho Lowlands. Uppsala University. Uppsala, Sweden.

Rydgren, B., 1988: "A Geomorphological Approach to Soil Erosion Studies in Lesotho", pp. 255-262 in Geografiska Annaler. Vol. 70A.

Rydgren, B., 1989: Soil Erosion and Nutrient Loss Studies in the Southern Lesotho Lowlands. Paper submitted to the International Soil Conservation Organization, ISCO 6, 11-15 November 1989, Addis Abeba, Ethiopia.

Schertz, D.L., 1983: "The Basis for Soil Loss Tolerances", pp. 10-14 in Journal of Soil and Water Conservation. Vol. 38, No. 1.

Schmitz, G. and Rooyani, F., 1987: Lesotho. Geology, Geomorphology, Soils. National University of Lesotho. Roma, Lesotho.

SIDA, 1983: Insatspromemoria ("Terms of Reference"). Mimeo. 10 October 1983. Stockholm.

SIDA, 1987a: SIDA's Guidelines for Project Support. Stockholm

SIDA, 1987b: Evaluation of the Institute of Land Use Planning and the Farm Improvement with Soil Conservation Project. Stockholm. Unpublished.

SIDA, 1990: Opinionsundersökningar om biståndsviljan i Sverige. Faktablad, maj 1990. Stockholm.

SIDA, 1991: Biståndsviljan i Sverige. Faktablad, februari 1991. Stockholm.

Snir, A. and Holland, D., 1986: Costs and Returns for Commercial and Semi-Commercial Orchards in Lesotho: Apples, Peaches and Pears. Agricultural Research Division, Ministry of Agriculture. Maseru, Lesotho.

SOU 1987:28: Bistånd för bättre miljö i u-land. Förslag om ett miljömål i utvecklingsbiståndet. Betänkande. Översyn av de biståndspolitiska målen. Stockholm.

Stocking, M., 1985: Erosion-Induced Loss in Soil Productivity: A Research Design. Consultant's Working Paper No. 2. AGLS, FAO. Rome.

Stocking , M. and Pain, A., 1983: Soil Life and the Minimum Soil Depth for Productive Yields: Developing a New Concept. Discussion Paper No. 150. School of Development Studies, University of East Anglia. Norwich, United Kingdom.

Stocking, M and Peake, L., 1986: "Crop Yield Losses from the Erosion of Alfisols", pp. 41-45 in Tropical Agriculture. Vol. 63. No. 1. Trinidad.

Stocking, M. and Abel, N., 1989: Labour Costs: A Critical Element in Soil Conservation. Paper to the 6th International Soil Conservation Conference, Addis Abeba, Ethiopia. University of East Anglia. Norwich, England.

Swallow, B.M., Brokken, R.F., Motsamai, 'M., Sopeng, L. and Storey, G., 1987: Livestock Development and Range Utilization in Lesotho. Research Division, Ministry of Agriculture. Maseru, Lesotho.

Swanson, E.R. and Harshbarger, C.E., 1964: "An Economic Analysis of Effects of Soil Loss on Crop Yields", pp. 183-186 in Journal of Soil and Water Conservation. Vol. 19. No. 5.

Swedforest, 1988: FISC Project. Phase II Plan of Operations. Third draft (15 April 1988). Swedforest Consulting AB. Stockholm.

Swedforest, 1989: Tender. Swedforest Consulting AB. Danderyd, Sweden.

Taylor, G., 1985: An Appropriate Shadow Wage Rate for LCU Projects. Mimeo. Ministry of Works. Maseru, Lesotho.

Vittal, K.P.R, Vijayalakshmi, K. and Rao, U.M.B., 1990: "The Effect of Cumulative Erosion and Rainfall on Sorghum, Pearl Millet and Castor Bean Yields under Dry Farming Conditions in Andhra Pradesh, India", pp. 429 - 439 in Experimental Agriculture. Vol. 26.

Weinmann, H., 1966: Report on Crop Research in Lesotho 1960-1965. Mimeo. Ministry of Agriculture. Maseru, Lesotho.

Wenner, C.G., 1982. Soil Conservation in Lesotho. Draft Discussion Document, March 15th 1982. Swedish International Development Authority. Maseru, Lesotho.

Wiggins, S.L., 1981: "The Economics of Soil Conservation in the Acelhuate River Basin, El Salvador", pp. 399-417 in Morgan, R.P.C. (ed.) Soil Conservation. Problems and Prospects. John Wiley & Sons. Chichester, England.

Wilken, G., 1982: Agroclimatic Hazard Perception, Prediction, and Risk-Avoidance Strategies in Lesotho. Dept. of Geography, Colorado State University. Working Paper no. 44.

Wischmeier & Smith, 1978, Agricultural Handbook 537, US Dept. of Agriculture. Washington, D.C.

World Bank, 1987: Project Completion Report. Lesotho Basic Agricultural Services Program Project. Washington, D.C.

Yaxley, E.L., 1987. Adoption of Fertilizer and Seed Recommendations by Farmers in Maphutseng, Lesotho. Mimeo. Institute of Land Use Planning, Maseru, Lesotho.

REFERENCE PERSONS[1]

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