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INCENTIVES SYSTEMS FOR NATURAL RESOURCES MANAGEMENT:

The Role of Indirect Incentives

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Food and Agriculture Organization of the United Nations (FAO)
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Preface

In response to a number of requests from the Governments of the Sahelian countries, IFAD has agreed to assist in the preparation of National Action Programmes under the framework of the International Convention to Combat Desertification (CCD). In initiating this work, incentive systems for Natural Resource Management (NRM) have been identified as a possible entry point, since this issue has not yet been addressed in a systematic and conclusive manner by the several CCD consultations at international, regional and national levels.

In this context, current options for NRM incentives include matching grants, food- or cash-for-work, provisions for tools, equipment, and social infrastructure, support to female-headed households to cushion the impact of male migration, and specific activities in favour of youth to encourage their participation in resource conservation activities instead of resorting to permanent migration. Beyond such short- and medium-term incentives, there is need for: (i) longer-term incentives relating to security of access to and control of resources; (ii) sectoral prices and subsidies (of both inputs and outputs); (iii) information on soil fertility management technologies; and (iv) decentralization of decision making and financing (through de-concentration, delegation, devolution and privatization). Finally, while the importance of the macro-economic environment is recognized, in many cases this is far from being a sufficient condition to bring about the desired changes in resource management practices at a local level.

Experience has also shown that different incentive systems are often used by different donors, even for target groups living in similar agro-ecologic or socio-geographic conditions. This lack of consistency in approach can create confusion and inevitably raises the issue of sustainability. The Convention's emphasis on beneficiary participation therefore offers an opportunity to reflect on optimal external incentive systems (i.e. those which are cost-effective, replicable and sustainable), which could also influence the resource users' choice in terms of sound natural resource management practices. This reflection should also provide an opportunity for governments to formulate appropriate policies in collaboration with development partners.

In 1996/97, IFAD initiated an action-research programme, in consultation with a number of agencies, aimed at assisting the concerned governments in the following areas: (i) the establishment of a consultative framework, at country level, for the systematic review and capitalisation of relevant experiences with NRM incentives systems; and (ii) the preparation of policy guidelines, based on best practices, to facilitate a progressive harmonisation of the terms and conditions of interventions by development partners.

The action-research programme started with a desk review of practical experiences with *direct incentives*, undertaken by the Free University of Amsterdam on behalf of IFAD. In addition to the specific findings related to direct incentives, the study also emphasized the importance of *indirect incentives*. Consequently, IFAD requested the FAO Investment Centre (FAO/IC) to undertake a study on *indirect incentives in NRM*, and this report presents the findings of the study.

It is proposed that the next steps would involve the participatory operationalization of the conceptual framework on NRM incentives, including validation, at country level, of the findings of the two studies. In each participating country, this should lead to a progressive harmonisation of approaches among development partners, based on a common understanding between all stakeholders concerning the incentive system practices which have already proven unsustainable - and, therefore, should not be replicated - as well as the various sustainable options, with a final choice being left to the communities. These options would vary according to agro-ecological zones and socio-economic conditions. The challenge would be to arrive at an indicative "mapping" of incentives packages by agro-ecological zone, which could be the object of fine-tuning in response to local socio-economic conditions.

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Acronyms and Abbreviations

ADP	World Bank Agricultural Development Project (Nigeria)
AHM	Agricultural Household Model
BCA	Biological Control Agent
CAP	Common Agricultural Policy (EC)
CBT	Construction Boom Theory
CCD	Convention to Combat Desertification
CFA	Communauté financière africaine franc
CGE	Computable General Equilibrium (Model)
CGIAR	Consultative Group on International Agricultural Research
CILSS	Permanent Interstate Committee for Drought Control in the Sahel
CPR	Common Property Resource
CSZ	Close-Settled Zone (Northern Nigeria)
DAP	Diammonium Phosphate
DC	Developed Country
EC	European Community
ERR	Economic Rate of Return
FAO/IC	FAO Investment Centre
FSG	Food Studies Group, Oxford
FSP	Farming Support Programme
FUA	Free University of Amsterdam
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GEF	Global Environment Facility
HYV	High Yielding Variety
ICRAF	International Center for Research in Agroforestery
IFAD	International Fund for Agricultural Development
IIED	International Institute for Environment and Development
ILCA	International Livestock Centre for Africa
ILEIA	Information Centre for Low-External-Input and Sustainable Agriculture
IMF	International Monetary Fund
IPM	Integrated Pest Management
LDC	Lesser Developed Country
NCS	National **Conservation** Strategy
NEAP	National Environmental Action Plan
NGO	Non-governmental Organization
NRM	Natural Resource Management
NSDS	National Sustainable Development Strategy
Ntb	Non-Tariff Barrier
O&M	Operating and Maintenance
ODA	Overseas Development Administration
OECD	Organization of Economic Cooperation and Development
PAF	Programme d'Action Forestier – Forestry Action Programme (FAP)
PRA	Participatory Rural Appraisal
PV	Present Value
RRA	Rapid Rural Appraisal
SAP	Structural Adjustment Programme
SMS	Safe Minimum Standard
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
WTO	World Trade Organization
WUA	Water Users Association
WWF	World Wide Fund for Nature

EXECUTIVE SUMMARY

i) Incentives structures are recognized as being important determinants of rural household behaviour. Concern with how farmers and pastoralists respond to the incentives they face, and the subsequent repercussions for the conservation of natural resources, is a key area of research interest. Moreover, the design of policies to encourage the sustainable use of these natural resources can benefit from an understanding of these linked decision-making and natural processes. Where natural resources are particularly fragile, as is the case in the Sahel and other dryland areas prone to desertification, the need to ensure that government policies and management regimes have the desired effect becomes even more critical. This desk study examines so-called ***indirect incentives****, which comprise those influences on producers' decisions that are not concerned with directly bringing about changes in the management of natural resources (NRM) through financial or similar inducements (****direct incentives****).*

ii) As a general review of a very diverse topic, the study does not attempt to present a unified or consistent viewpoint throughout, in recognition of the often contradictory views held by researchers and the relatively immature state of knowledge on many aspects. For this reason, perhaps the main conclusion of the study is that very definitive generalizations concerning the linkage between specific indirect incentives effects and NRM are not appropriate at this time. In the majority of cases, the indirect incentives effects of specific policies are difficult to nail down and may vary from highly positive to equally strongly negative under differing resource endowments, cultural contexts and household strategies. Notwithstanding the above, it should not be inferred that there is nothing to be learned from studying indirect incentives and their impact on NRM. Indeed, it is clear that distortions and inappropriate policies which lead to an undervaluation of the natural resource base create poor incentives for its maintenance and sustainable use.

iii) Much potential exists for the confusion of terminology, especially regarding the concepts of direct and indirect incentives. In looking at indirect incentives, we distinguish ***variable incentives****, which may alter a producer's NRM decisions, from the incentives associated with the* ***enabling environment*** *within which these decisions are made. In the first case, we refer to actions on the part of governments that bring about production changes at the farm level. An example of such actions might be policy-induced modifications in producer prices. Also important are non-agricultural sector developments over which agricultural planners may have little or no control, or which have unintended impacts on small producers. Ultimately, most variable incentives operate by altering the net returns that producers can earn from cropping, livestock management or soil and water conservation activities.*

iv) ***Enabling incentives*** *instead stem from policies which bear on the enabling environment, and therefore work in a more roundabout way on producer behaviour. Of principle interest is the influence of land tenure on NRM decision-making, but incentives issues relating to collective action in the management of common property resources and government intervention in NRM are key aspects as well. Enabling incentives also include information about soil and water conservation technologies and more sustainable cropping practices provided to producers via government research and extension programmes. Complementing information transfer is the availability of credit, which can be required if producers are to invest in certain types of improved land management, particularly those involving structural measures.*

v) NRM problems result from a multiplicity of underlying factors and interacting mechanisms and an understanding of these is imperative in the study of issues associated with indirect incentives. Physical resource attributes and socio-economic factors create the conditions for land degradation to occur but may not compel it. In many cases, farmers are aware of the potential for their lands to degrade but may be constrained or discouraged from making the necessary improvements. Market and policy failures may be primarily at fault: since farmers do not reap all the benefits of improved land management, the socially optimal level of investment in land improvements will not occur. Government policies may aggravate the situation by creating the wrong incentives for conservation instead of correcting for market failure. Current thinking on the causes of resource degradation emphasizes the role of market and policy failures, inappropriate institutions and government policies, as well as the interaction of compounding or 'disabling' factors such as poverty, population growth and income or asset distribution.

vi) In light of the above description of the problem, Figure 1-4 (see main text) presents the study's conceptual framework, which is centred on the process of household decision-making concerning the use of its natural resource base. Given its endowment of natural, human and technological resources, the household makes decisions under the constraints or incentives imposed by the enabling environment. In this regard, tenure and other factors both create and limit the opportunities available to the household. Variable incentives determine the net returns, risks and other pecuniary elements entering into the decision-making process and, in this sense, the structure of variable incentives imposes further constraints (and opportunities) on household decision-making. There are the additional cross-cutting considerations of poverty and population growth that influence household decision-making but are distinct from indirect incentives.

vii) At the core of the conceptual framework are farmers' perceptions. Changing incentives or net returns signal to the farmer that the use of household resources for a particular purpose may no longer be desirable and that resource reallocations may be necessary. Many options are available if farmers wish to respond to perceived changes in their production environment. Whether these activities will have a positive or negative effect on NRM depends on such factors as how they are carried out, what crops/animals are involved and whether they are maintained over time, amongst others. Feedback mechanisms close the loop and lead either to self-reinforcing improvements in NRM or spiralling degradation, which can eventually culminate in the collapse of the farming or grazing system.

viii) Commencing with a consideration of ***variable incentives****, we distinguish incentives stemming from policies at the sectoral level from those associated with macroeconomic policies. As a result of the recognized role of net returns in stimulating either good or bad farming practices, a key area of research has been the influence of sectoral pricing on NRM, whether of outputs or inputs. It is necessary to distinguish between aggregate production responses to higher prices, which can be manifested in higher yields or an expanded cropping area, and crop switching, which occurs when relative crop prices change and substitution of one crop for another takes place. Conclusions regarding the effects of these mechanisms for NRM are difficult, particularly with respect to output pricing, since a wide range of varying crop characteristics (e.g. erosive versus non-erosive) and production responses (e.g. extensification versus intensification) must be considered and these are liable to be highly location-specific.*

ix) As an example of the type of analysis envisioned we can consider tobacco, for which the output response to a change in the producer price is quite strong. As tobacco is typically a highly erosive crop and additionally requires large inputs of fuelwood for curing, there is an indication

of a negative degradation effect in tobacco-growing areas when the tobacco price rises, on the assumption that tobacco will displace less erosive land uses (i.e. crop switching). Thus, output price increases in this case constitute a significantly negative indirect incentive for NRM. With respect to aggregate production responses, where land of at least passable quality is available and a sufficiently long timeframe is considered, extensifying may be a more common response to higher prices. If marginal, fragile lands are involved, degradation can be the result. However, higher prices may also stimulate better management of non-frontier natural resources as they now become more valuable, but ancillary effects may be mixed. Certainly, reductions in the volatility of prices, or price risk, would seem to induce better resource management, as this permits producers to take a longer-term perspective in managing their resources.

x) At first glance, subsidies on agricultural inputs provide a more obvious relationship with NRM. Where the inputs in question are unquestionably harmful to the environment (e.g. pesticides), inducing greater use would seem to be negative for NRM. However, even here caution is advised. In most cases, there are important substitution effects at work when input prices are adjusted and the implications of these for NRM must be considered as well. For example, draft animals may substitute for tractors, manure or mulches for inorganic fertilizer and integrated pest management (IPM) for pesticides. The extent to which substitution may actually occur will depend on how perfect these practices substitute for each other, their relative prices/costs and their availability: manure and mulches are often limited in supply and thus cannot fully substitute for inorganic fertilizers. Furthermore, modern agrochemicals have at least some role to play in the process of agricultural transformation in Africa, and there is little evidence of over-use of these inputs and the associated damages at present, except in areas of intensive land use.

xi) Some specific concerns regarding subsidies, input usage and variable incentives include the following:

- *Inorganic fertilizers have both positive and negative consequences for NRM, as they contribute to beneficial intensification but can displace more sustainable options or mask underlying soil depletion, so that subsidies may be good or bad;*

- *Pesticides can cause well-known damages when applied excessively or incorrectly and subsidies can contribute by encouraging the over-use of calendar or pre-emptive spraying or, in the area of IPM, by artificially lowering the damage thresholds at which spraying is done;*

- *Irrigation water subsidies, particularly when combined with inappropriate pricing mechanisms (e.g. unit area pricing) encourage overwatering and degradation, leading to declining profitability and further diminishing prospects for cost recovery and investment in system upkeep; and*

- *Mechanization (tractor) subsidies can distort production decisions long after they are dropped because of the lifespan of such capital equipment, while substitution effects vis-à-vis draft power are complex because of the mixed benefits and costs of this latter technology.*

xii) In addition to sectoral policy influences on NRM, there is increasing evidence that policies at the macroeconomic level can have a substantive impact on NRM. A myriad of distortions created by inappropriate exchange rates, taxes and interest rates, combined with expansive fiscal and monetary policies, can alter the allocation of resources in ways that affect NRM at the household level. For example, indirect effects stemming from macro level policies

have been shown to dramatically reduce the effective prices paid to producers in Côte d'Ivoire and Ghana. Once the full economy-wide effects of such policies are taken into account, the impacts may be much greater than at the sectoral level alone. Distortions in natural resource institutions or in pricing at the sectoral level, however, may exacerbate the undesirable effects of macroeconomic policies. Thus, without imperfections in tenure security or the underpricing of biomass resources, to cite two possible distortions, the environmental consequences of macroeconomic reforms may be significantly less or even negligible.

xiii) Various macroeconomic policy links with incentives for improved NRM can be highlighted for Africa:

- *Expansive fiscal and monetary policies have characterized many of these countries with consequences for inflation, interest rates and exchange rates. The resulting macroeconomic imbalances reduce economic stability and discourage farm level investment in improved land management.*

- *High debt service ratios encourage expanded export production to generate the needed foreign exchange earnings, and this can harm NRM if it creates incentives to expand these activities onto marginal, fragile lands or involves erosive annual crops.*

- *High inflation can stimulate investors to invest in land, as a hedge against the declining value of assets in other forms, with generally negative consequences for NRM, especially if there are legal requirements for land clearance as a condition for continued ownership.*

- *Overvalued exchange rates provide incentives similar to artificially low producer prices or input subsidies but the effect is concentrated on tradable goods. Thus, high input commercial agriculture using imported tractors and agrochemicals is favoured over low impact pastoral and subsistence cropping systems.*

- *Protectionism in some West African countries creates incentives for the economically inefficient and potentially damaging cultivation of irrigated rice and wheat.*

xiv) Many of the recommended reforms at the macroeconomic level have been bundled together under structural adjustment programmes (SAPs). Given their multi-faceted nature, SAPs are likely to have widespread but uneven NRM effects through their intended impacts on producer prices and other incentives. Levels of compliance help to condition the economic and environmental response: members of the CFA franc zone, for example, have relatively poor records in this regard. Similarly, international commodity price developments have tended to moderate some of the intended changes in producer incentives. Case study research in West Africa supports the contention that SAPs have had both positive and negative consequences for NRM. However, some researchers argue that a SAP's more important influence on NRM results from a roundabout process involving initial effects on social structures, income distribution and other socio-economic conditions. These effects then lead to impacts on NRM via the sorts of cross-cutting, compounding effects of poverty and commercialization discussed previously.

xv) On an even more aggregate scale, biases in the global trade system against commercial agriculture in developing countries have implications for NRM. Although African countries are generally much less excluded from Western markets than other developing countries, they still suffer from depressed prices for their commodity exports, in comparison to a distortion-free trade

regime. This situation has incentives effects on export cropping, product mix and other aspects of domestic production, some of which are negative while others positive for NRM. Trade liberalization, while generally criticized in many quarters, has commensurately equivocal results for NRM, as evidenced in empirical studies. However, most analyses concede that while liberalization's global benefits are probably positive overall for the environment, the developing countries may incur some negative costs. Africa's experience is liable to be muted because of existing preferential trade arrangements and other factors.

xvi) ***Enabling incentives*** *mediate the household's potential response to the variable incentives discussed above, and thus help determine cultural practices and land management. Of particular interest are the enabling incentives associated with alternative institutional responses to non-existent property rights (open access) and deteriorating or displaced traditional institutions. Such interventions may come in three guises:*

- *Privatization of land as a form of increased tenure security, which can have consequences for the incentives to invest in land improvements.*

- *State intervention through nationalization, sedentarization or collectivization policies, which can be disruptive of local level NRM institutions, or decentralization, by which governments may beneficially shift NRM responsibilities from the formal level to a more informal one.*

- *Collective action can aid the conservation and management of common property resources, which may include shared farm or pastoral management systems and systems for water resource allocation (irrigation), pest control and the harvesting of various products from common and private lands.*

xvii) By providing more security to the farmer and by providing collateral to the lender, tenure security is argued to bring about increased investment, more demand for inputs and subsequently increased output levels and higher land value. From an NRM perspective, this line of reasoning is particularly applicable to investment in structures for soil and water conservation, since these are more likely to involve out-of-pocket costs. However, in general such linkages between land tenure and investment in land improvements are not as strong as previously supposed. Neither agricultural nor pastoral sector studies provide conclusive evidence that privatization has increased investments in land productivity or motivated sustainable practices and, in some instances, it has had the opposite effect on NRM. Privatization may be desired by benefiting producers because it guarantees land rights, but it does not necessarily bring about changes in their natural resource use strategy.

xviii) Land titling can have more pervasive effects, some of which have negative consequences for NRM. For example, analyses of tenure systems in some African countries show that privatizing land tenure can promote land grabbing, concentration of ownership, de facto expropriation of land or user rights held by women, landlessness and increasing marginalization. Privatization may also extinguish secondary land rights, affecting women and seasonal herders who may depend on these forms of traditional tenure for their livelihoods. In the latter case, conferring land tenure rights on sedentary agriculturalists may disrupt a system of pastoral semi-nomadism, based on rights of passage and dry season grazing, which may create disincentives for the sustainable management of these lands as residual pastoral areas. In contrast, research indicates that traditional institutions governing access to land resources are flexible in responding to internal and external pressures. Thus, radical changes in traditional systems of

tenure may not be necessary to enable them to operate adequately and to avoid the insecurity of access rights which can undermine NRM.

xix) Contrasting with privatization, the assumption of state ownership of resources represents a form of centralization of control, which governments are not always able to support properly, given the limited resources available for the management of vast lands and for the enforcement of formal legal controls. National governments also may have distant and antagonistic relations with local communities, making efficient management of natural resources difficult and instilling disincentives at the local level. Furthermore, governments may manage state lands for purposes other than wise use or local welfare, instead emphasizing such objectives as rent or revenue extraction or self-serving political ends. State intervention can be defended in some cases, as part of a transition process during which communities experience a decline in traditional institutions and new institutions have not yet fully evolved to replace them.

xx) On the other hand, decentralized systems of NRM, initiated and supported by governments, can provide appropriate incentives for improved NRM under certain circumstances. In Africa, the process of decentralization has sometimes been undermined and clearly it cannot work where it is done without due diligence by governments wishing to escape responsibilities or where opportunities are created for conflict or local élites to take control. Concomitantly, local level institutions cannot operate in isolation from the formal bodies which exert an important influence on informal authorities and on household decision-making. Local institutional capability and strength also appear to be significant factors in dictating how well natural resources are managed at this level under decentralization and how communities govern their resources in relation to outsiders, particularly when faced with potential appropriation.

xxi) Intervention in the management of land and other natural resources through land titling or state ownership presupposes that alternative institutional strategies are not viable. However, there is ample evidence that cooperative arrangements, often based on traditional institutions, can work in the management of certain natural resources. Successful efforts to support indigenous common property arrangements rely upon recognition of the conditions most likely to foster collective action, but clearly, these do not exist in every case. For example, some researchers argue that for collective action to work, discount rates cannot be too high, the interactions characterizing NRM problems must be of long duration, the rewards to defection must not be too great and punishments facing defectors must be very costly to the defector. Other researchers find that the key variables influencing the potential success of collective action are the number of decision-makers, especially the minimum number required to attain a collective benefit, a similarity of interests among agents, and the presence of some individuals with leadership or other assets.

xxii) While titles to land or increased security may increase the ability of producers to invest, it does not always increase their willingness to invest. This lack of willingness to improve their land may be due to the absence of other user enabling incentives such as information regarding appropriate technologies and access to credit facilities or other necessary infrastructure. Access to agricultural support services can also serve as a hedge against the adverse effects of insecure institutions by enabling producers to make improvements in production systems and NRM, despite these uncertainties. Organizations may have an important role in promoting resource management by providing such services and may be a contributing factor in affecting the producer's willingness to adopt improved NRM.

xxiii) However, competing paradigms with respect to research and extension services may have different implications for NRM. New thinking on the issue of appropriate extension mechanisms emphasizes a "farmer first" approach. In this paradigm, the transfer of technology, which is the usual objective of conventional extension systems (e.g. training and visit), is superseded by a supportive approach to the development of indigenous farming and an educative approach to NRM technology options. The new approach has implications for NRM, since its promotion of indigenous, low-input farming techniques may result in fewer negative impacts on NRM in comparison to the standardized, high-input techniques promoted by conventional extension programmes. Moreover, the complementary land husbandry approach to arable farming and NRM emphasizes the integration of soil conservation techniques into farming practices rather than the promotion of these in isolation. It may provide more appropriate incentives for improved NRM than many conventional soil and water conservation methods. For example, farmers may have greater incentives to adopt practices involving 'win-win' inputs, which both increase output and reduce soil erosion, instead of techniques which trade off these two objectives.

xxiv) An assessment of the study's implications for NRM in West Africa and for desertification control must take account of regional conditions or the 'action space'. The Sahelian Zone has been described as rich in land area but poor in land quality and physical and financial assets. Combined with a highly variable and harsh climate, the incentives to choose between extensification and intensification become a critical issue, and probably favour the former. The eradication of onchocerciasis undoubtedly reinforces this observation. Fluctuating international commodity prices and droughts in the 1970s and 1980s may have raised farmers' perception of risk and increased their concern with NRM. In addition, the stagnating and declining economies of the West African coastal region mean that fewer opportunities for seasonal and semi-permanent migration exist. Governments in the region have been increasingly willing to adopt reforms, whether structural adjustment or decentralization programmes (e.g. Mali), and this is paralleled by a reduced willingness on the part of donors to provide assistance unconditionally. All these developments combine to define and modify the incentives for NRM as part of a broad, dynamic regional system.

xxv) Given the above conditions, conservation measures which provide good incentives to farmers in the form of increased net returns, and also meet economic efficiency criteria, are preferred to those that do not. But there are many cases in which there is a divergence between the national interest in the conservation of natural resources and the private interest of the farmer, which suggests a need to examine farm-level incentives. A careful analysis should be able to distinguish the sources of distortion in incentives, i.e. whether these chiefly originate at the sectoral or macroeconomic level. Appropriate policy analyses are required to determine whether modifications in the offending policies are possible (or desired), or whether mitigating or 'second best' approaches to correct for distortions are advised. Developing an understanding of farmers' perceptions of the causes and effects of degradation and of their likely response to alternative means of conservation and differing incentives is also an essential element in the design of any programme.

xxvi) This study suggests that the analysis of indirect incentives must take account of shifts in the paradigms governing thinking about NRM, as these new ways of thinking can have radical implications. One observation is that new thinking tends towards a greater emphasis on the enabling environment over the reforming of variable incentives alone. In particular, improved pastoral system management requires a better enabling environment, since variable incentives

are much less important. For example, herders use few purchased inputs but rely significantly on marketing and infrastructure support, which are important components in opportunistic management strategies. In addition, simply targeting poverty or population growth as a means of addressing land degradation is no longer seen as the most effective route. Yet the role of policies in inadvertently fostering impoverishment and the link with the poverty-degradation trap cannot be ignored. It is, instead, the failure of markets, policies and institutions in the first instance, compounded by these factors, that is at the root of poor NRM.

xxvii) Macroeconomic policy-making must also consider the emerging recognition of its surprisingly large influence on NRM. One of the key policy debates in the literature concerns the relative efficacies of macro-level policies versus targeted environmental policies in addressing resource degradation problems. First, best approaches to resolving macro imbalances may hold the potential for worsening degradation, if failures at the sectoral level are not addressed. While 'getting the prices right' may be one means of redressing failures at the sectoral level, 'getting the macroeconomic environment right' may be equally important to support these reforms. The points just made suggest that neither macro nor sectoral corrections implemented alone are sufficient, and coordination at both levels may be the key to an effective response. Such thinking has further implications for the redesign of structural adjustment programmes.

xxviii) We have already noted that good soil and water conservation need not involve the construction of conventional structures for the entrapment of soil and water. Instead, it may be achieved with better land husbandry, particularly the use of land management and tillage systems which maximize in situ water capture and retention, thereby both reducing potentially destructive run-off and improving conditions for crop growth. These practices do not require substantial inputs of capital or credit, but instead rely upon support for indigenous methods or the transmission of new knowledge and information to farmers. Increasingly, it may be the enabling incentives associated with these support services which can produce the greatest benefits for NRM, rather than smallholder credit programmes or land tenure reforms, both having largely failed in the past. Yet extension services that support sustainable agricultural technology and provide appropriate knowledge to farmers and pastoralists are critically lacking in Sub-Saharan Africa. Guaranteeing the necessary support to producers is crucial, so that they can make sustainable modifications in their farming practices, but requires commensurate inputs from public agencies. A 'farmer first' approach, employing participatory methods and in which households are active partners in research, may be appropriate.

xxix) In the pastoral sector, a principal aim of public institutions concerned with the provision of services to herders should be to tailor support to their management strategies, which in turn are closely tied to evolving indigenous tenure systems. Typically, these include opportunistic management strategies involving a high degree of mobility and highly flexible use rights over land. Thus investing in public infrastructure and marketing reforms which support opportunistic management may be preferred to more conventional investments in rangeland rehabilitation or the regulation of herd size, in keeping with the new thinking in this area. Research strategies and extension facilities need to take account of the variability facing rural households and to develop approaches geared towards non-equilibrium environments, if they are to support herders with sustainable production strategies. By creating an improved decision-making environment, including improved market access, government services can help herders to make sound investment decisions, taking advantage of credit facilities and other user-enabling incentives

xxx) As a final note, improved research methodologies are called for if analyses of land degradation and policy linkages are to produce more definitive conclusions. Incorporating some of the new thinking described above would lead to studies which go beyond the erosiveness of particular crops and the prospects for crop switching under policy changes, and look at broader changes in the farming system and management of its resource base. Incentives are needed to foster the development of practices which better suit agroecological conditions and the process of agricultural transformation, however slow this may be proceeding. At the macroeconomic level, there is a further need for information systems, such as green accounting initiatives, which help to highlight the plight of a nation's natural resources. Further development of general equilibrium modelling, especially computable general equilibrium models, is needed to clarify the links between existing policy stances and NRM, as well as to assess the full impact of policy reforms.

1. INTRODUCTION

1.1 Incentives structures are recognized by most practitioners in the field of development studies as being important determinants of rural household behaviour. Nowhere is this likely to be more true than in the more narrowly focused discipline of environment and development. Concern with how producers respond to the incentives they face, and the subsequent repercussions for the conservation of natural resources, is a key area of research interest. Moreover, the design of sound policies to encourage the sustainable use of these natural resources can benefit from an understanding of these linked decision-making and natural processes. Where natural resources are particularly fragile, as is the case in the Sahel and other dryland areas prone to desertification, the need to ensure that government policies and management regimes have the desired effect in toto becomes even more critical. This desk study addresses several aspects of the topic outlined above by examining the literature on so-called indirect incentives. We look at definitional issues in more detail in the next section, but for now we can think of indirect incentives as influences on producer behaviour which do not stem from a direct attempt to change this behaviour through the use of financial or in-kind inducements.

1.2 The study[1] is one element in a broader effort by IFAD to provide assistance for the implementation of the International Convention to Combat Desertification (CCD). The Convention addresses the problem of dryland degradation and desertification first recognized globally as a result of a major Sahelian drought in the 1970s. The 1977 United Nations Conference on Desertification, which adopted a Plan of Action to Combat Desertification, was the response. After a rather unsuccessful period of implementation, the Plan was revisited at the 1992 UN Conference on Environment and Development, at which time it was decided that a more formal agreement in the form of a convention would be needed as a basis for future efforts to address the problem. The International Convention to Combat Desertification (CCD) was adopted on 17 June 1994 and as of 15 October 1994, it had been signed by 85 countries.

1.3 Defining what is meant by desertification has proven to be a difficult task. Recent attention tends to be focused on the term ‘land degradation’ as a somewhat broader concept than desertification, but having no reference to aridity in particular. For example, the CCD refers to land degradation as “the reduction or loss of the biological or economic productivity and complexity of the land” (Puigdefabregas 1995, p. 311). Other sample definitions include the following:

> “Desertification has been defined as the expansion of desert-like conditions and landscapes to areas where they should not occur climatically or where they did not occur in historical times.” (Le Houerou 1986, p. 446)
>
> “Desertification is a process of sustained decline of the biological productivity of arid and semi-arid land: the end result is desert, or skeletal soil that is irrecuperable.” (Gorse and Steeds 1987, p. ix)
>
> “... land degradation in arid, semi-arid and dry sub-humid areas resulting mainly from adverse human impact.” (UNEP 1991)

[1] Principal author Duncan Knowler, University of York, UK, assisted by G. Acharya and T. van Rensburg

> "... land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors including climatic variations and human activities." (UNCED 1992)

1.4 As the above definitions hint at, one of the key issues in the desertification debate concerns the role humans have played in causing the problem. Until recently, it was assumed that human use of lands at risk had been a major source of desertification, especially in the Sahel-Sahara Desert borderlands. However, recent assessments have raised questions about the validity of this view. A series of studies aimed at monitoring the advancement of the Sahara Desert has not indicated any systematic movement attributable to other than short-run climatic factors and proposed that much longer-term studies would be required to detect any permanent expansion of the desert (Tucker *et al* 1991). As a result of these studies and other evidence, Hellden (1991) argues that there is "a lack of data to substantiate the hypothesis of a secular, mainly man-made, trend towards desert-like conditions in the Sahel" (p. 372), and feels a reassessment is necessary. Other writers are cautious in attributing responsibility for desertification to human activities, recognizing that only a narrow range of practices may be at fault (Mortimore 1985). Current thinking seems to take a median position, recognizing that human influence may not be as predominant as earlier thought, but assuming that there remains some culpability, perhaps as a triggering mechanism (Puigdefabregas 1995, Thebaud and Toulmin 1994).

1.5 A consequence of the definitional problem is the difficulty of identifying areas which can be formally described as 'desertified'. One set of estimates prepared by the World Resources Institute and the International Institute for Environment and Development (IIED), and reported by Cleaver and Schreiber (1994), indicates that on a world-wide basis, land degradation involves some 3.3 billion ha or about 61% of total productive drylands. In the Sudano-Sahelian region of Africa, the extent is 473 million ha or a sizeable 88% of productive drylands, comprising mostly rangelands (80%) and secondarily, rainfed cropland (19%). The same source also provides data on soil erosion in a selection of Sub-Saharan African countries, with affected areas constituting as much as 88% of national crop or grazing lands (Lesotho).

1.6 Desertification contributes to a general problem of land degradation in many countries, with significant costs to national economies, as a consequence. For example, Bojo (1996) has reviewed various estimates of annual land degradation costs for a selection of Sub-Saharan African countries and finds these range from US$ 0.3 million per year in Lesotho to US$ 155 million per year in Ethiopia. Furthermore, he shows that these costs represent shares of agricultural GDP running from less than one percent to 9 percent.[1] Estimates of the costs of various forms of land degradation in several West African countries (Burkina Faso, Mali and Nigeria) run from 0.9% to 17.4% of national GDP's (Barbier and Bishop 1995). Thus, the need to design appropriate policies and incentives to combat desertification is apparent, as these will be critical to inducing changes in those practices which are the root causes of the problem.

A. BACKGROUND AND CONCEPTUAL ISSUES

1.7 Undertaking an investigation of the influence of incentives on natural resource management (NRM) requires that certain key concepts be clarified at the outset. For this reason, this section reviews the many definitions and taxonomies relating to the concept of incentives and briefly examines the notions of natural resource management and land degradation, to bring focus

[1] The selected countries included in the review are Ethiopia, Ghana, Lesotho, Madagascar, Mali, Malawi, South Africa and Zimbabwe.

to the subsequent sections of the study. We are careful to avoid substantive overlap with the previous study by the Free University (1996), concentrating instead on the notion of indirect incentives, but locating these within the broader context of incentives structures. A further rationale for exploring these topics stems from the need to be specific about what incentives for NRM are meant to accomplish. This can be understood best by considering what constitutes good NRM and what producer level measures are needed to attain this desirable outcome. Only then does it make sense to discuss how policies or incentives influence producers. Finally, we develop a conceptual framework for the study which has at its core, NRM decision-making at the household level. Numerous authors have addressed this latter topic and we examine this literature in more detail in the Appendix to Chapter 2. In the meantime, we draw from that review here, integrate it with current thinking on the role of incentives and their consequences for NRM, and develop a unifying framework to provide coherence to the study and guide the analysis of subsequent chapters.

The Concept of Incentives

1.8 Incentives may be broadly defined, as in "everything that motivates or stimulates people to act" (Giger 1996). What is important about such a broad definition is that it allows for incentives to be of either a passive or an active nature. In the former case, we can think of incentives as signals in the producer's environment which influence decision-making about farming practices, whether intended or otherwise. Many macroeconomic policies, being remote from the producer and targeted at objectives other than promoting sustainable farming practices, would fit into this category. In contrast, the notion of 'active' refers to a government's ability to actually design or modify policies with a desire to bring about certain conservation outcomes. McNeely (1988), for example, refers to this concept of incentive when he defines incentives as "any inducement which is specifically intended to incite or motivate governments, local people, and international organizations" (p.38-39). We draw this distinction because of the need to consider both active and passive aspects when assessing the importance of incentives for NRM. While governments may be most concerned with the design of good policies aimed at improving NRM, they need to be cognizant of the sometimes counterproductive influence exerted by a poor incentive structure, in the passive sense.

1.9 McNeely (1988) also makes the useful distinction between incentives, disincentives and perverse incentives. In contrast to incentives, which we have described above, disincentives are purposely designed to discourage particular behaviours and can include taxes, fines and various other penalties or moral suasion. For purposes of this study, we will not consider disincentives as distinct from incentives per se, but it is useful to be aware of the distinction. In contrast, perverse incentives incite resource users to damage or deplete the resources in question in a socially inefficient manner and are closely related to the concept of policy failure, which is discussed in Chapter 2.

1.10 The Free University of Amsterdam, in their study of incentives for IFAD (FUA 1996), further distinguishes direct from indirect incentives. The former refer to efforts by governments or external agencies to bring about improvements in natural resource management (NRM) through in kind, cash or mixed inducements, and constitute the focus of their study. In contrast, by indirect incentives they mean actions or conditions which affect behaviour but operate more remotely from the producer, such as fiscal measures, legislation and the provision of technical or social services, as examples. Clearly, this definition of indirect incentives permits them to operate in

either an active or a passive way, as we have discussed above. We can further distinguish the two by considering direct incentives as having direct budgetary implications for conservation activities, whereas indirect incentives do not (McNeely 1988).

1.11 There is liable to be some confusion of the concept of a direct or indirect incentive with other related terms such as subsidies, which Roodman (1996) describes as "a government policy that alters market risks, rewards and costs in ways that favour certain activities or groups" (p.12). The Free University study differentiates between incentives, as defined above, and subsidies, which are said to be of a purely pecuniary nature. Giger (1996) instead refers to subsidies as an instrument used to create incentives and goes on to describe compensation as a further, distinct category, entailing payments to individuals for the supply of services of a public good nature. From the economist's perspective, direct incentives are meant to correct a discrepancy between the financial attractiveness and economic desirability of an action, and can presumably consist of subsidies or any other financial measure. Thus, for our purposes, terms such as compensation are more closely associated with direct incentives whereas subsidies can create either a direct or an indirect incentive, depending upon the commodity or activity to which they are applied. In Chapter 3, we examine the role of subsidies on purchased agricultural inputs, which are a major influence on NRM at the farm level.

1.12 That such potential for the confusion of terminology exists demonstrates the rather arbitrary way in which definitional distinctions are made, especially regarding the direct and indirect concepts. In the end, it may be best to de-emphasize such a taxonomy and concentrate on alternative, and perhaps more useful approaches, several of which exist. For example, Perrings (1996), Conway and Barbier (1990) and Pearce *et al* (1988), referring broadly to what we have called indirect incentives, break these down into essentially two categories:

(a) *variable incentives*, such as prices, exchange rates, trade restrictions, interest rate policy, taxes and subsidies, etc.;

(b) *user enabling incentives*, referring to elements in the producer's environment which affect decision-making behaviour, such as security of tenure, socio-economic conditions, information about technologies, producer support services or credit availability.

1.13 There are obviously many ways to define a term as generally applied as 'incentives' and it is not our intent to explore this issue in great detail (for example, see Free University 1996, Pretty 1996, Dixon *et al* 1989, McNeely 1988). For our purposes, it is useful to adopt a distinction similar to that offered by Pearce *et al*, as presented above. Thus, we distinguish between the *variable incentives* associated with government policies or developments at an international or domestic level which may alter producer's NRM decisions, and the incentives arising from the 'enabling' environment within which these decisions are made. In the first case, we refer to actions on the part of governments to bring about specific changes at the farm level, mostly originating from within the agricultural sector itself. An example of such actions might be policy-induced changes in producer prices. However, we cast our net wider to capture those non-agricultural sector developments over which agricultural planners may have little or no control, or which have unintended impacts on the small producer. Examples of these non-agricultural considerations would include exchange rates, economy-wide taxation or subsidy policies, national interest rates, and international price movements or 'shocks'. Ultimately, most variable incentives

operate by altering the net returns which producers can earn from cropping or soil and water conservation activities.

1.14 *Enabling incentives* instead stem from policies that bear on the enabling environment, and therefore work indirectly on producer behaviour. Of principle interest is the influence of land tenure on NRM decision-making, which we explore in some detail (Chapter 5). However, the enabling environment also includes incentives issues relating to collective action in the management of common property resources and government intervention in NRM, the latter sometimes beneficial (e.g. *decentralization*) and sometimes less so (e.g. *collectivization. sedentarization*). Enabling incentives also include the information about soil and water conservation technologies and more sustainable cropping practices provided to producers via government research and extension programmes. Complementing information transfer is the availability of credit, which can be required if producers are to invest in certain types of improved land management, particularly structural measures. Added to these enabling incentives are modifications to other government services, such as marketing assistance, which can similarly influence producer behaviour in an indirect way.

The Concepts of Natural Resource Management and Land Degradation

1.15 Incentives are clearly linked to the problem of natural resource degradation. Perrings (1996) defines the problem of environmental degradation as "a structure of incentives that makes it privately rational for resource users to place more pressure on the resource base than it can absorb without suffering long lasting and perhaps irreversible damage" (p. 139). This description also highlights the potential for divergences between social and private interests in resource use decisions. The process of natural resource degradation can be described quite usefully in these conventional neoclassical economic terms, but benefits from a somewhat broader institutionalist view as well (Swanson 1996). We discuss some of these causation-related issues, such as market and policy failures, in more detail in the next chapter. In this section, we address the nature of degradation, emphasizing the 'new views' in both cropping and range management, which are shifting thinking about what represents good NRM. We particularly focus on West African and Sahelian conditions.

1.16 Mortimore (1985) has described the practices potentially associated with land degradation and desertification in West Africa, although we note below that some of the linkages to desertification are tenuous and have come under question (Mortimore is cautious on this point as well). With respect to cropping, he cites inadequate fertilization, leading to impaired nutritive status and structure of soils, the practice of leaving fields bare for periods of the year and the consequent loss of soil through deflation (wind erosion), the declining quality of fallow vegetation, and long-term declines in soil fertility, which impair biological productivity. In contrast, conventional soil and water conservation revolved around keeping soil in place and preventing rainfall from becoming runoff and eroding soils. As a result, combating soil and water erosion was inextricably linked with structural measures to address these problems. Examples of successful projects in West Africa taking such an approach include Oxfam's Project Agro-forestier (PAF) in Burkina Faso, which used a rock bund technique to trap runoff and eroding soils, with significant yield and other less tangible local benefits (Younger and Bonkoungou 1989). In addition, there are many examples of projects in West Africa involving more costly concrete drainage and related works for which the success rate is much lower (FAO/IC 1990).

1.17 The structural approach involving costly channelling works has come under criticism from researchers and practitioners such as Norman Hudson, Francis Shaxson and others, who are associated with the Land Husbandry movement. The Land Husbandry view is concerned with maintaining land and soil productivity by integrating good practice into the farming systems of individual producers. Table 1-1 contrasts the two views and raises an interesting point for our analysis of indirect incentives: there are different approaches to improving NRM and these may be associated with quite different forms of incentives, whether direct or indirect. For example, where structures are seen as the means to improve NRM, then various subsidies on materials and credit schemes would be effective, whereas the Land Husbandry approach would be more closely tied to participatory techniques for the transmission of conservation information and the cultivation of greater farmer control over NRM.

Table 1.1 Different Views of Soil and Water Conservation

Traditional Focus	Land Husbandry Focus
• loss of soil and water	• loss of productivity
• physical conservation works on the surface	• improvements in soil conditions at and below the surface
• how much soil and water is lost	• how much water and soil retained
• uni-disciplinary approach, distinct from normal agricultural practice	• multi-disciplinary approach, based on and strengthening normal agricultural practice
• runoff control	• water absorption/infiltration
• add-on conservation technologies	• techniques integrated into conservation-effective farming systems
• farmers as labour for implementing works	• farmers as managers of conservation-effective systems
• doing soil and water conservation by decree	• achieving conservation of soil and water as a by-product of improved productivity
• works costing money	• exploiting free actions by soil meso- and micro-organisms
• assumption that specialists' perceptions of degradation problems and their solutions are correct – outsiders judge what is best	• awareness that other views of the reality may require different types of approaches - farm households decides what's best
• small farmers are considered ignorant, irrational and reactionary	• small farmers are knowledgeable about their local circumstances, but also constrained and understandably cautious in adopting new ideas

Source: FAO/IC 1993

1.18 Pretty (1995) has also discussed the objectives of a sustainable food and fibre production system, concentrating on the incorporation of the following:

- natural nutrient processes and pest-predator relationships;
- reduced use of damaging, modern inputs;
- greater productive use of genetic potential and local knowledge;
- social improvements such as increased self-reliance among farmers and greater equity in access to productive assets;
- a better match between land capabilities and farming practices; and

- more emphasis on integrated production systems which include conservation.

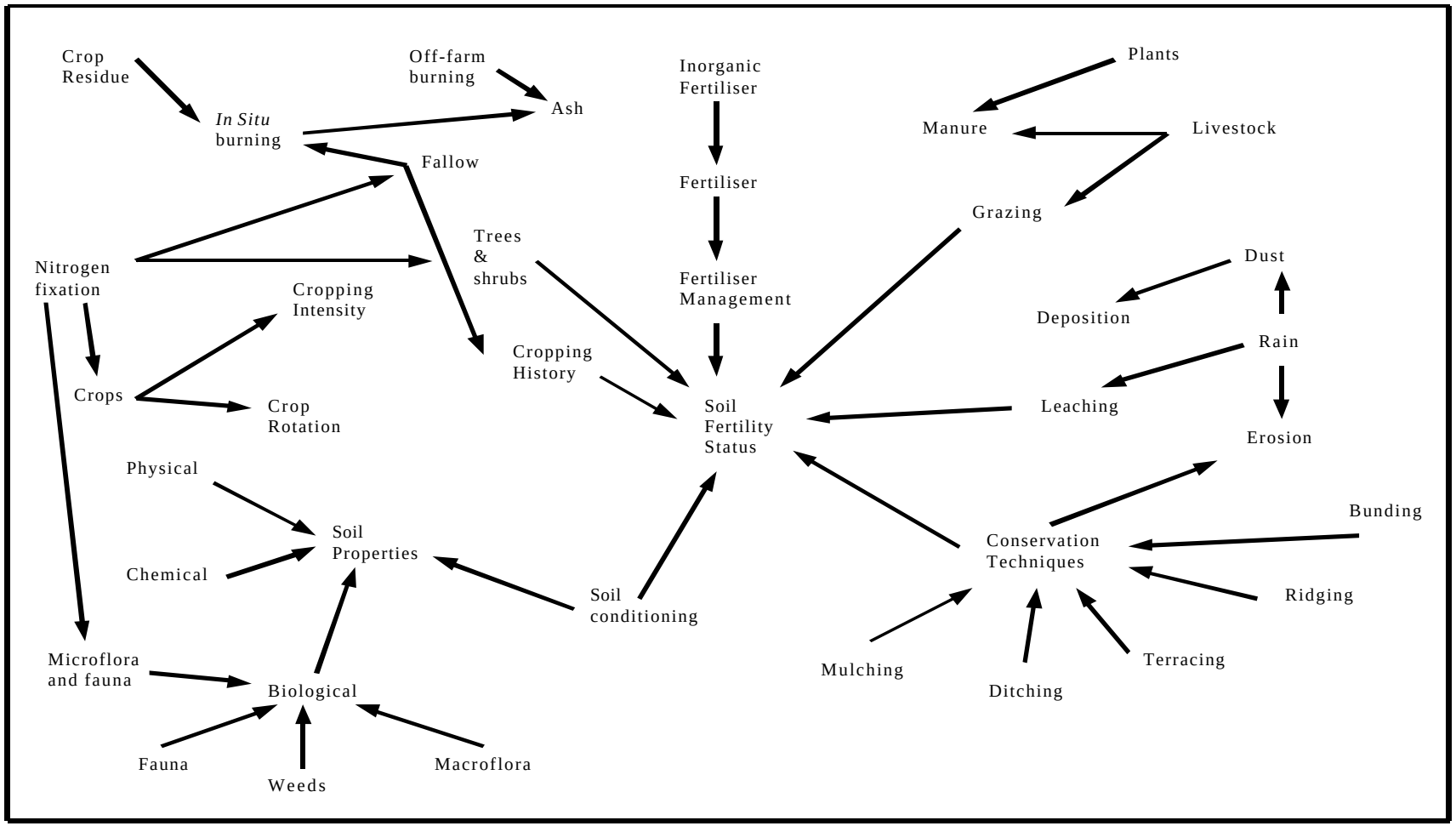
1.19 Pretty's approach emphasizes the split between proponents of 'sustainable' agriculture and those recognizing the inevitability of agricultural modernization through the adoption of production-enhancing inputs, which include improved varieties, mechanized power, fertilizers and pesticides (Pingali *et al* 1995). The latter school sees modernization as the key to fostering the intensification which is required to meet the nutritional needs of a growing population and in response to land pressure.

1.20 Good resource management is not restricted to cropping practices alone but must be extended to crop-livestock interactions and pastoral systems as well. Regarding the former, Bayer and Waters-Bayer (1989) suggest that sustainable agriculture would be promoted where:

- dual-purpose crops are encouraged which not only lead to higher food grain yields but also increase fodder supplies or quality;
- the efficiency of using crop residues for fodder is improved;
- draught animals are encouraged at the expense of tractors;
- the protection of existing fodder-producing trees and shrubs and the planting of additional ones is encouraged; and
- a better understanding is gained of tropical agroecosystems, especially with respect to nutrient transfer, the role of fire, changes in vegetation composition and their implications for crop and livestock production.

1.21 The last point noted above is an important one, particularly for fragile but complex agroecosystems, such as those of the Sahel. While establishing a set of good practices to manage Sahelian soil and range resources may seem straightforward, it is not. The good management of sub-Saharan African agroecosystems requires the juggling of many different activities, involving multiple and interacting system components. Figure 1-1 illustrates this complexity by showing the dozens of factors thought to influence soil fertility in northern Nigeria, some being natural (e.g. rainfall) while others are subject to management (e.g. conservation techniques). Given such a complex system, incentives might be expected to have similarly complex and subtle influences, as there are many ways in which external actions may affect an agroecological system such as the one represented by Figure 1-1. It is not hard to imagine that changing prices for outputs, fertilizers, labour and credit might radically alter the current management of soil fertility via any of several possible pathways shown in the Figure.

Figure 1.1: Factors Influencing Soil Fertility



Source: Phillips-Howard & Lyon (1994), after Phillips-Howard & Kidd (1991).

1.22 Range management presents somewhat different problems from annual cropping, since there is a more profound dynamic element present. Figure 1-2 shows some of the complex dynamic aspects of the drought cycle and the parallel movements in important system variables, i.e. livestock prices, forage availability, substitute grain prices and livestock numbers, which often characterize the cycle. Practices associated with the degradation of rangelands and having possible links with desertification include:

- the replacement of annual with perennial grasses, which reduces seasonal plant cover;
- trampling in areas of high animal density leading to soil structure damage;
- encroachment of unpalatable species due to overgrazing of palatable ones;
- and the destruction of browse resources from excessive lopping and seedling destruction (Mortimore 1985).

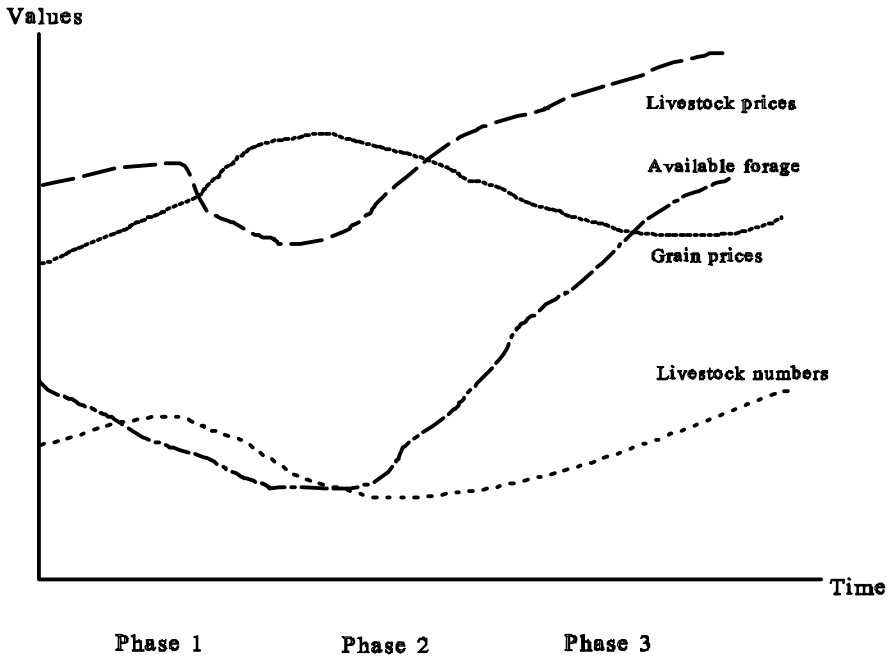
1.23 Not all these practices have been shown to have discernible impacts on desertification; for example, Hellden (1991) argues that remote sensing studies do not demonstrate progressive desertification associated with degradation around waterholes and densely populated areas in grazing zones. Even so, various grassland ecology studies have demonstrated that greater plant species richness (biodiversity) increases rangeland stability in response to disturbances and maintains a more constant flow of primary production under fluctuating climatic conditions (McNaughton 1985, Tilman and Downing 1994). Where there is unrelenting grazing pressure, a decline in the contribution from certain grass species may occur, with consequences for livestock productivity.

1.24 In response to the lack of success in combating rangeland degradation under conventional range management and conservation practices, the emphasis has been shifting to new approaches, similar to the situation involving cropping and soil and water conservation described above (Behnke and Scoones 1992). Conventional range management has concentrated on establishing appropriate stocking rates, based on estimates of long-term carrying capacities and successional rangeland models, without much recognition of the climate and market uncertainties characterizing African grazing systems in the shorter run. Efforts to incorporate more flexible strategies, often referred to as opportunistic management, are now being espoused (Behnke and Scoones 1992, Toulmin 1996).

1.25 The opportunistic management approach derives from a different view of the behaviour of rangeland systems over time. Instead of a successional process with equilibrium as its eventual resting place, the rangeland system is seen as subject to uncertainty and disequilibrium influences, which are better described by the state-transition model (Westoby *et al* 1989). Depending upon climate and management, the system may shift from one vegetative state to another, with some of these states much more productive for livestock than others. The task is therefore to take advantage of potential shifts which can improve livestock productivity and prevent ones that do not. Ultimately, this calls for a strategy in which desirable states are encouraged by ensuring livestock numbers closely ‘track’ rangeland productivity, which calls for rapid marketing responses and other interventions suited to this objective (Sandford 1996). Holtzman and Kulibaba (1996) present a list of possible livestock marketing improvements which support opportunistic management of African livestock and rangeland resources.

Figure 1-2: The Drought Cycle

Source: Toulmin (1996)

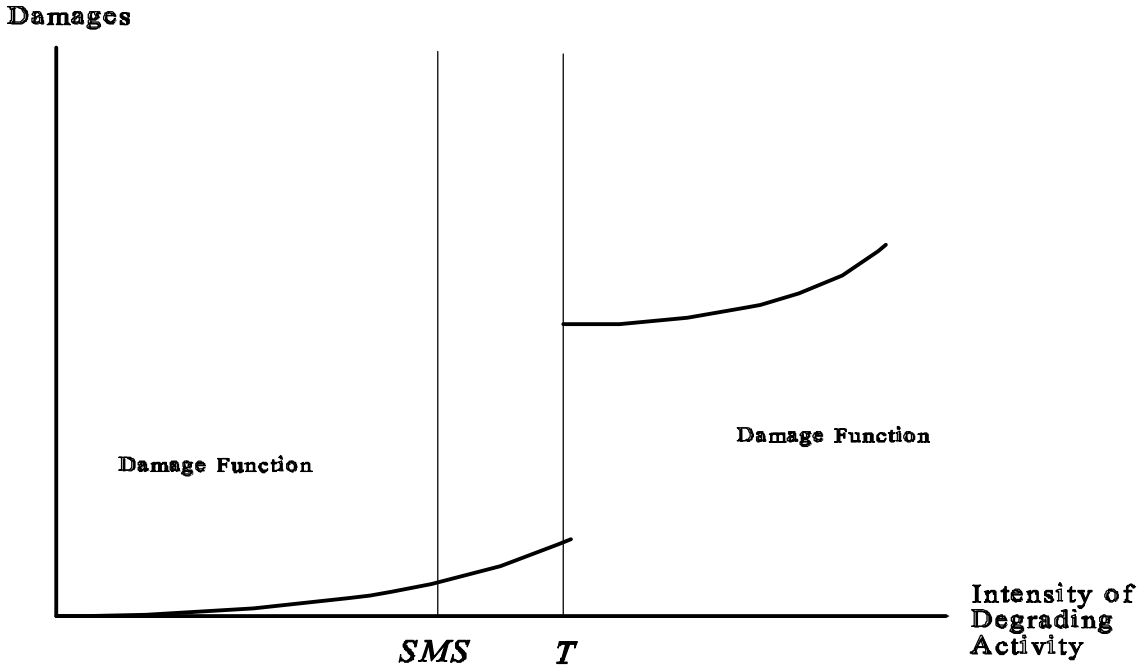


1.26 We have seen that good NRM represents a set of practices which maintain the productivity of a natural resource. However, the pastoral management case demonstrates that the potential for degradation also hinges on the underlying physical attributes of the resource and the immediate physical environment, including climatic variables. Maintaining the productivity of the deep volcanic soils of Java is quite a different - and much less challenging - problem than doing the same in a Sahelian context, where the climate is much less predictable and the soils are much poorer and characterized by much shallower profiles (Gorse and Steeds 1985). Where such conditions exist, physical attributes will play a more important role in determining the resource outcomes from various NRM practices, which in turn stem from the incentives structure faced by producers. Moreover, the vulnerability and fragility of Sahelian natural resources has enormous feedback implications for the proper management of these resources. For example, thresholds may exist beyond which further resource degradation cannot be reversed. There may also be sudden 'jumps' in resource productivity, as a result of external stresses and shocks or poor management practices, as implied by the state-transition model.

1.27 Perrings and Pearce (1994) analyze the threshold problem in the context of biodiversity conservation but their approach can just as usefully be applied to cropping and range management, where the underlying resource base is fragile and vulnerable to perturbations. Figure 1-3 shows the damage function which describes the economic losses associated with worsening management practices, the latter perhaps involving degrees of poor cropping practices or inappropriately high stocking rates. As these cropping or range management practices worsen, damages mount until a threshold (point T) is reached, at which time there is a large jump in the damage function. Often, point T will not be known because information about the resources in question may be inadequate. In these extreme cases, a more cautious resource management approach is advised, referred to as a safe minimum standard, which is consistent with the notion of the Precautionary Principle.[1] The point SMS in Figure 1-3 indicates a level of crop or range management which builds in a buffer or cushion against the potential losses incurred at T. Thus, limiting management practices to levels no worse than SMS would insure against the large losses associated with management level T. Selecting SMS can be tricky, since there are liable to be some social opportunity costs involved and society must be willing to tolerate these, in order to avoid much greater but more uncertain losses. Clearly, the influence of indirect incentives on the management of natural resources subject to thresholds may impose additional concerns.

[1] The Precautionary Principle is relevant where making decisions about the conservation of important natural resources involves uncertainty. As we do not know the probabilities or magnitudes of losses from allowing degradation to proceed, there is the possibility of severe losses if key Sahelian soil and range resources are not conserved. Society may be willing to pay a premium to avoid these losses, just as individuals purchase insurance protection. In the Sahelian case, nations may wish to preserve important but fragile agricultural resources as long as the cost or "premium" is not too high. Determining this limit is not easy but may involve a least-cost perspective (O'Riordan and Cameron 1994).

Figure 1-3
Natural Resource Degradation, Thresholds and the Safe Minimum Standard



Source: Perrings and Pearce 1994

Definitions: *SMS* -- safe minimum standard
T -- damage threshold

1.28 The physical nature of resources may also influence whether their productive functions may be replaced using alternatives. Such considerations stem from the view that natural resources constitute 'natural capital', in contrast to the manufactured or produced capital represented by tractors, irrigation systems, etc. One view assumes that natural and produced capital can be substituted -- the so-called weak sustainability hypothesis -- so that the loss of natural capital can be mitigated by increasing the amount of produced capital to compensate. A more restricted view of the substitutability of natural and produced capital is offered by the strong sustainability school, which holds that such substitution cannot be guaranteed since natural capital is often characterized by unique properties and, therefore, once lost cannot be replaced. Management approaches such as the SMS reflect this fear of possible 'irreversible' natural resource losses. In Chapter 3, we consider which of the two options applies in the case of maintaining soil fertility.

1.29 In addition to physical resource attributes, there are other considerations in recognizing or defining natural resource degradation, such as economic and institutional aspects. Panayotou (1990) describes what constitutes poor NRM employing an economist's perspective. Box 1-1 presents his list, which complements the descriptions of good NRM practices mentioned earlier. These manifestations of poor NRM raise the question of what causes resource degradation, discussed in the next chapter, and make the point that degradation is not simply a decline in resource stocks, as Swanson (1996) has pointed out. He argues that the latter may occur as a calculated management choice, as when a society chooses to convert a resource in one form to a stock of financial wealth with sustainable social returns. This alternative sustainable path contrasts with the option of managing use of the resource itself sustainably, and it need not entail social losses, which instead are associated with true natural resource degradation. Furthermore, some resources may not provide sufficient net social returns to warrant their sustainable management, even once all potential social costs from using them up are counted. Instead, Swanson argues that resource degradation is present when some underlying institutional imperfection prevents the resource from being used in the most socially desirable way. Thus, the importance of underlying institutions in NRM is emphasized, and by extension the performance of these institutions will be inextricably linked with the notion of indirect incentives. In the next chapter, it will be shown that some of the root causes of degradation can be traced to market or policy distortions of an economic or institutional nature. In Chapter 5 we explore in more detail the links between NRM and selected institutions.

Box 1-1 An Indicative List of the Economic Manifestations of Environmental Degradation

Panayotou (1990) presents a useful list of what constitutes poor NRM, emphasizing an economics perspective on the problem, in an attempt to get at the root causes of degradation. The list is the following:

1. Overuse, waste and inefficiency coexist with growing shortages, such as is found with respect to water use in the irrigation sectors of many countries.
2. An increasingly scarce resource is put to inferior, low-return and unsustainable uses when superior high return and sustainable uses exist, such as occurs with inappropriate conversion of grazing land to highly subsidized cropping.
3. A renewable resource capable of yielding a perpetual stream of benefits with a positive present value is exploited as an extractive resource, as occurs when soil resources are 'mined'.
4. A resource is put to a single use when multiple uses would generate larger net benefits, as may occur when monocropping displaces more sustainable, multiple-cropping systems.
5. Investments in the protection and enhancement of the resource base or changes in cultural practices are not undertaken even though they would generate net benefits by enhancing productivity and sustainability; this may occur with land improvements or the adoption of better cropping practices commensurate with soil and water conservation.
6. A larger amount of effort and cost are incurred when a smaller amount of effort and cost would have generated a higher level of output, more profit and less damage to the resources, such as when pastures are overstocked in relation to optimal strategies.
7. Local communities and tribal groups are displaced and deprived of their customary rights to resources even when by virtue of their physical presence, intimate knowledge and vested interest, they would have been the most cost-effective managers of the resource; a common example of this is the establishment of wildlife reserves where traditional grazing and other uses are forbidden.
8. Public projects are undertaken that do not make adequate provisions or generate adequate return to compensate all those affected (including the environment) to a level that they are decidedly better off with the project rather than without it.
9. Resources and by-products are not recycled when recycling would generate both economic and environmental benefits, such as may occur if the integration of cropping and livestock systems does not occur or degenerates.
10. Unique sites and habitats are lost and animal and plant species go extinct without compelling economic reason to counter the irreversible loss of uniqueness, diversity and options, as may be associated with the impacts of certain irrigation developments on West African wetlands.

Source: adapted from Panayotou (1990)

B. A CONCEPTUAL FRAMEWORK FOR ASSESSING THE ROLE OF INDIRECT INCENTIVES

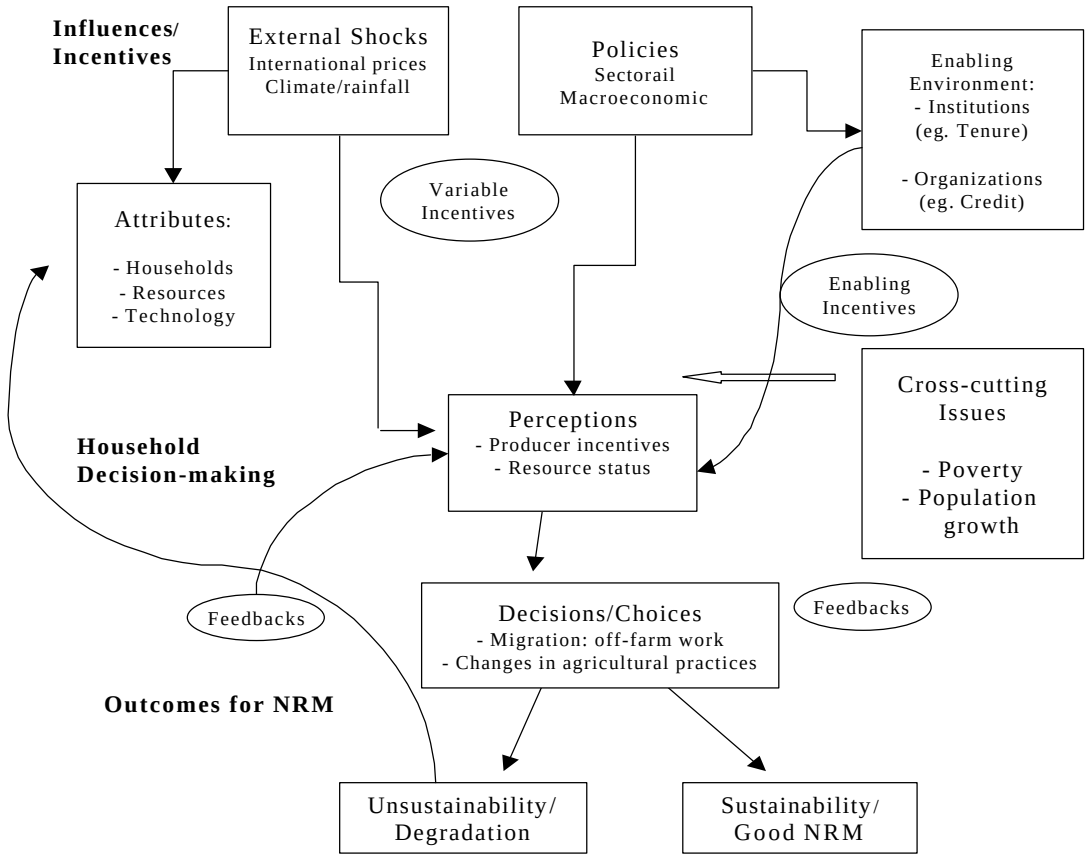
1.30 A number of authors have attempted to capture the complex set of physical, economic and social interactions, which contribute to the process of degradation, within a single conceptual framework (Reardon and Vosti 1995, Pearce and Warford 1993, Anderson and Thampapillai 1990, Dixon *et al* 1989, Ervin and Ervin 1982, Earle *et al* 1979).[1] Drawing on this previous work, Figure 1-4 presents a conceptual framework which is tailored to this study and should help in elucidating its main themes. The framework is centred on the process of household decision-

[1] Several of these conceptual approaches are presented elsewhere in this study, as they tend to emphasize certain aspects more so than others. See, for example, Figures 2-2 and 2-3.

making which determines how the natural resource base under the household's control is used, given the level of technology and the socio-economic characteristics of its members, i.e. the *attributes.* Given this endowment of natural, human and technological resources, the household makes decisions about their use under the constraints or incentives imposed by the 'enabling environment', as described earlier. In this regard, tenure and other factors both create and limit the opportunities available to the household. For example, lacking access to capital, the household cannot invest in land improvements which require large initial expenditures. In contrast, inputs of information and technical expertise can open the way for changes in farm practices which improve the management of its resource base.

1.31 Variable incentives determine the net returns, risks and other pecuniary elements entering into the decision-making process and in this sense, the structure of variable incentives imposes further constraints (and opportunities) on household decision-making. Moreover, variable incentives are directly affected by external developments and policies. Policies also influence enabling incentives more indirectly, through the intermediary of the enabling environment. We will later argue that there are additional disabling, compounding and cross-cutting considerations such as poverty and population growth, which influence household decision-making. These influences are presented as distinct from variable and enabling incentives effects. Via feedback effects and other processes, cross-cutting influences and external shocks act on the natural and human resource attributes of the household, expressing themselves in declining arable land or production per capita and the seasonal absence of household members seeking work in urban areas.

Figure 1-4
A Conceptual Framework for the Study of
Indirect Incentives
in Natural Resources Management



1.32 At the core of the conceptual framework are farmers' perceptions. Changing incentives signal to the farmer that the current use of household resources may no longer be desirable and that resource reallocations may therefore be necessary. For example, as relative output prices change, there may be a wish to plant more of one crop and less of another and the choices made will obviously have implications for NRM. Farmers must also be aware of degradation problems if they are to respond to these by improving NRM. There is controversy over the extent to which farmers do perceive progressive deterioration in their natural resource base. Later we cite evidence to indicate that there can be such awareness amongst smallholders, although this may be masked at times by other factors affecting production. Detection of natural resource degradation results from the working of feedback mechanisms which are portrayed in Figure 1-4 as dashed lines. Feedbacks serve a useful purpose in driving aspects of the decision-making process and confound the view that NRM can be portrayed as a purely linear process.

1.33 Many options are available if farmers wish to respond to perceived changes in their production environment. We choose to concentrate on a few, namely the possibility for all or a few of the household's members to migrate or accept off-farm employment, and the option to remain behind and modify farming practices. Critically, the impact on NRM can be either positive or negative, depending upon numerous factors. If households choose migration, they may reduce the intensity with which they farm existing plots, or abandon their old lands altogether and bring new land in frontier areas under cultivation. The latter can have quite serious implications for NRM if unsustainable practices are inappropriately transferred to new areas.

1.34 There are many alternatives available to producers if instead they choose to change existing agricultural practices rather than migrate, including:

- crop switching;
- intensification or extensification;
- investing in land improvements, such as tree planting, construction of structures;
- changing cultural practices, such as planting cover crops or vegetative strips;
- increasing or decreasing stocking/offtake rates for livestock; and
- investing in animal health or supplementary feed.

1.35 Whether these activities will have a positive or negative effect on NRM depends on how they are carried out, what crops/animals are involved and whether they are maintained over time, amongst other factors. Degradation is a physical process and is also contingent upon the physical nature of the natural resources in question. These factors will help to determine what effect any farming system modifications have on the underlying resource base. Through the working of feedback mechanisms, the loop is closed and there is then the potential for either a self-reinforcing series of improvements in NRM, or spiralling degradation which can eventually culminate in the collapse of the farming or grazing system, if left unaddressed.

C. SCOPE AND OUTLINE OF THE STUDY

1.36 As implied by the title of this study, its emphasis is on 'indirect', as opposed to 'direct' incentives and NRM. In particular, we concentrate our attention on NRM with respect to the soil and water conservation aspects of sustainable agriculture, excluding consideration of forestry-related issues, and primarily from the economist's perspective. In many respects, the study is

concerned with whether indirect incentives facing producers ultimately lead to sustainable or unsustainable agricultural practices. This view requires that we assess how producers make decisions about their resource endowments and trace through the effects of changing incentives on resource allocation choices. Once made, these choices will determine the outcomes or impacts on the natural resource base, but these will hinge on the physical characteristics of the natural resources in question and other factors as well. Feedback effects ensure that the process is dynamic.

1.37 As ultimately the IFAD/CCD programme is concerned with government actions designed to improve NRM, we concentrate more on the agricultural planners' repertoire of policy tools, particularly output and input pricing, rather than treat macro-economic policy and the environment extensively. However, in saying this we recognize that policy actions outside the agricultural sector may well determine the success of NRM incentives schemes originating within the agriculture sector. Moreover, recognizing the perverse incentives created by policies or conditions outside the agriculture sector will be important for the efficient design of incentives for NRM, whether these are intended to work directly or indirectly. Similarly, we restrict the analysis to areas of policy relevance and not to incidental factors in the producer's environment which may not be amenable to policy intervention. One exception to this rule is external shocks, such as major international price movements, since these can have far-reaching effects on NRM and in the end may require intervention of some kind to limit their impact.

1.38 It is apparent from the discussion of previous sections that we are concerned primarily with incentives for NRM at the producer level, and not at the national level, for example. That is not to say that incentives do not operate at the national or other levels. The Global Environment Facility (GEF), for example, is intended to alter incentives at the national level for this very purpose -- that is, to bring about an improvement in NRM from a global perspective. As pointed out in the FUA study, incentives are also important at the community level. This may be especially true where commonly used resources are concerned, and where there is a desire to improve the management and use of these resources. For this study we will restrict our focus largely to indirect incentives for NRM facing producers at the household level, since the control of productive resources for agriculture chiefly rests here (see below for exceptions). Even in the case of incentives for collective action in the management of common property resources, the behaviour of individuals can be argued to rely, at least partly, on their own perceived interest with respect to the collective.

1.39 A further distinction we must make is between the behaviour of sedentary farmers and pastoralists. Although the agro-ecological context is important to both, it seems especially so for the pastoral environment, particularly in light of the new thinking on pastoral management which is emerging (Scoones 1996). The pastoral context may also differ from that of cropping in that collective action has greater currency. Where taking such a view is appropriate to the study's aims, we adopt the collective perspective. Rather than treat pastoral and rangeland issues under separate headings, we have tried to integrate these into the main flow of text. Furthermore, we restrict our geographical focus primarily to West Africa, using a loose definition for this region which at times includes nearby countries such as Cameroon and Chad, and leave out some of the smaller, coastal West African countries because of space limitations.

1.40 With the above considerations in mind, the structure of the report itself reflects the conceptual framework outlined in Section 1.B Chapter 2 establishes the role of compounding, disabling and cross-cutting influences on NRM, such as population growth, migration and poverty. These factors have been shown to play a role in the process of land degradation, but not

one which can be described simply as 'causal'. Their interaction with indirect incentives, or indeed their role as incentives themselves, is portrayed in Figure 1-4 and ultimately complicates the analysis. The chapter also addresses the main factors and priorities influencing producer behaviour and makes observations about why producers allow their natural resource base to degrade, a central component in the conceptual framework presented in Figure 1-4.

1.41 Chapter 3 looks at the role of agricultural sector policies on NRM as variable incentives. How do producer pricing and mechanized farming, pesticide and fertilizer subsidies create or limit the incentives for soil and water conservation? It concludes that generalizations are difficult given the anecdotal, site-specific nature of most writings on the topic and lack of empirical research in key areas. Nonetheless, an attempt is made to generalize where possible. Chapter 4 extends the variable incentives discussion to the macro policy level and international market influences. These are liable to be more remote from producers but more pervasive than influences emanating from the agricultural sector alone, since they may involve economy-wide actions which have general as opposed to partial equilibrium effects. Most discussions of exchange rate manipulations, for example, concentrate on their effects for agricultural production directly and not on the wider impact on labour markets and the full consequences for NRM. We try to address this shortcoming of some analyses. A key issue here is the advent of Structural Adjustment Programmes (SAPs) in Africa, and these are reviewed in some detail.

1.42 In Chapter 5, we consider the factors circumscribing smallholder behaviour regarding natural resource use, the so-called 'user-enabling' incentives. This includes the institutional and property rights regimes in place, including incentives for collective action, as well as the flow of technical information to households and the importance of credit availability to NRM. Finally, Chapter 6 extracts conclusions from the analyses of earlier chapters and discusses their implications for an understanding of the role of indirect incentives in combating desertification, particularly in the Sahelian countries.

2. CAUSES, CROSSCUTTING ISSUES AND PRODUCER DECISION-MAKING IN NATURAL RESOURCE DEGRADATION

2.1 The previous chapter outlined in very general terms what is meant by indirect incentives and natural resource degradation. This chapter examines standard theories of causation in the process of degradation but adds a discussion of complicating factors operating at the aggregate level. The latter include population growth, migration and poverty, and a consensus is emerging that these problems do not directly cause degradation. Instead, they are liable to compound other causal factors, mediate responses by producers to degradation or drive parallel processes such as intensification, which can have beneficial implications for NRM. Thus, their role with respect to indirect incentives is not clear: they may modify incentives originating from other sources (i.e. price effects) or they may influence producer decision-making more directly (see Figure 1-4). This latter proposition demonstrates the importance of producer decision-making with respect to natural resource use. Indeed, macro-level manifestations of land degradation must be seen as the result of many micro-level decisions made by individual producers.

A. MARKET AND POLICY FAILURES AND LAND DEGRADATION

2.2 The manifestations of poor NRM described in Chapter 1 result from a multiplicity of underlying factors and interacting mechanisms (Harrison 1987). Physical and socio-economic factors create the conditions for land degradation to occur but may not compel it. In many cases, farmers are aware of the potential for their lands to degrade but may be constrained or discouraged from making the necessary improvements. One view is that market and policy failures may be primarily at fault: since farmers do not reap all the benefits of improved land management, the socially optimal level of investment in land improvements will not occur. Government policies may aggravate the situation by creating the wrong incentives for conservation instead of correcting for market failure. Current thinking on the causes of resource degradation emphasizes the role of inappropriate institutions and government policies, as well as the interaction of compounding or 'disabling' factors such as poverty, population growth and income or asset distribution (Swanson 1996, Pearce and Warford 1993). The sections below explore these threads in the literature and attempt to draw out some implications from the perspective of indirect incentives and NRM. We begin with the more conventional neoclassical economics approach to the degradation problem.

2.3 The conventional view of degradation attributes the situation to distortions in markets and failures in policy-making and asserts that improvements can be made only by correcting for these faults. Market failures in the form of *externalities* have especially been seen as the root cause of many problems of degradation.[1] Bojo (1991) cites externalities and a lack of risk and futures markets as market failures commonly associated with land degradation, all of which are applicable to West Africa. Both temporal and spatial externalities may exist, but the externality aspect of soil degradation and loss of on-farm productivity is not so obvious, since the farmer bears the immediate cost of this loss. This point is often overlooked in arguments supporting the externality view of land degradation. However, since many Sahelian countries are at or near a food deficit situation, declining production from lands subject to degradation exacerbates the

[1] Externalities refer to the presence of third party effects. These can be described as social costs from production which are imposed on individuals against their will and where no offsetting compensation is made. Health damages arising from air pollution constitute an externality since manufacturers and drivers of vehicles do not take these costs into account when deciding how to build or drive their vehicles unless forced to do so by governments.

already precarious food security situation, possibly causing a temporal externality (FAO/IC 1991, Cleaver and Schreiber 1994, see Table A-10). Either per capita nutritive intake must fall, or imports must rise; both cases pose problems for future generations.

2.4 Spatial externalities from land degradation consist chiefly of off-site sedimentation of reservoirs and watercourses, although there has been controversy over the significance of such effects (Southgate and Macke 1989). Spatial impacts may also be associated with joint users of open access grazing and forest resources, the latter including losses of non-timber values due to the overexploitation of forests. An additional externality in savanna regions results from the burning of vegetation, which provides immediate gains to agriculturalists but can have damaging effects on longer term productivity. In addition to externalities, there is inadequate risk protection available to farmers, causing them to have high private discount rates and thus view investments in land improvements less favourably (Bojo 1991).

2.5 We can further differentiate between unidirectional and reciprocal externalities (Dasgupta and Maler 1994). The former are those cases where the costs imposed on third parties flow in one direction only, as when upland farmers deforest and this causes impacts on lowland farmers or farmers higher up on an irrigation system appropriate water supplies for themselves, thus restricting flows to downstream users. Reciprocal externalities involve two-way flows of costs, so that individuals are both perpetrators and recipients of third party costs, as occurs with automobile pollution of the atmosphere. More importantly for land degradation problems, reciprocal externality characterizes most common property resources, such as grazing and other commonly held agricultural lands, an important characteristic of many Sahelian agroecological systems. Private property rights have not been established for various reasons, and so a process ensues whereby the many users impose costs on each other, all the while overexploiting the resource in question.

2.6 The externality problem is just one of many market and policy failures at work in the process of resource degradation. Lack of markets for some resources also complicate their efficient allocation; here we could cite many non-timber forest products, which have been shown to contribute significantly to West African livelihoods (Falconer 1990). Non-market valuation techniques are useful for overcoming this problem in project analysis but are less meaningful at the household level where many NRM decisions are made. Some newer techniques attempt to capture the values implicit in these resource use choices made by households (IIED 1994). Policy failures originate with governments, but as Warford and Pearce (1993) point out, the distinction from market failure is vague; if it is up to governments to correct for market failure then not doing so would constitute a policy failure. Nonetheless, governments do act in ways which exacerbate market imperfections and further stress already fragile rural natural resource bases, as demonstrated by some of the West African examples given in Box 2-1. Further discussion of the way policy actions may act as indirect incentives for NRM is deferred to later chapters and the next section, which considers population growth, migration and poverty as factors in the degradation process, with consequences for an understanding of indirect incentives and NRM.

Box 2-1 Policy Failures Linked to Land Degradation in West Africa

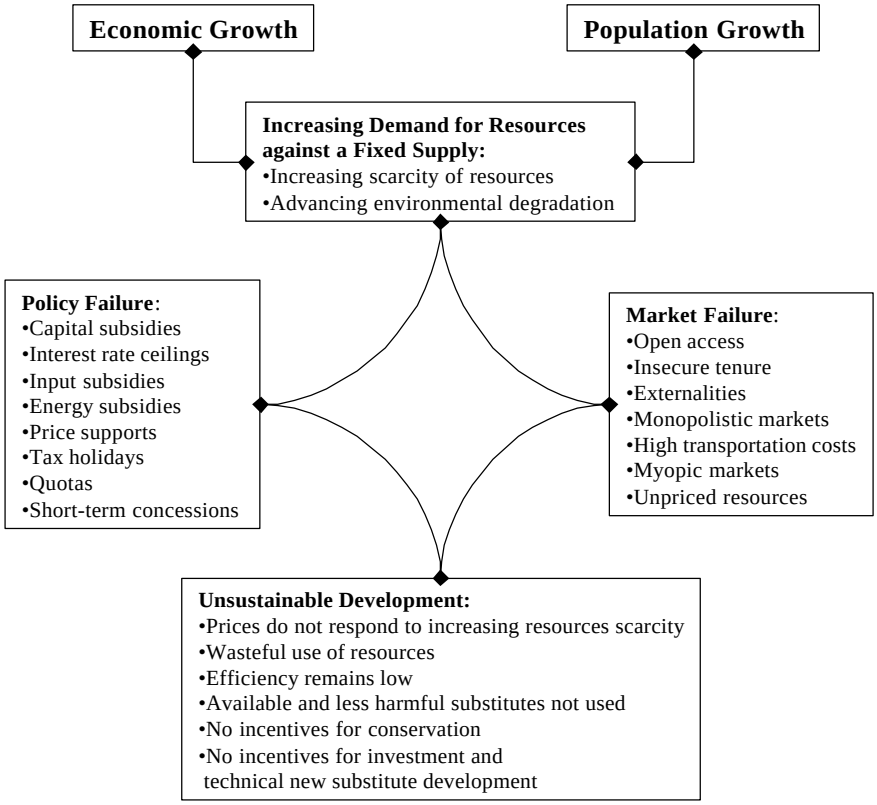
Ghana and Nigeria face serious land degradation problems: these range from a pervasive decline in soil fertility to forest and woodland destruction. Sheet and wind erosion are also significant, the latter being more prevalent in Nigeria than in Ghana, as is severe gullying. Burning of bush and cropped areas is widespread in Ghana and one of the major sources of soil physical deterioration and declining productivity. Irrigation creates localized problems of soil salinity and waterlogging in both countries. From an economics perspective, land degradation in Ghana and Nigeria demonstrates a classic divergence between public and private interests, as a result of market and policy failures. Despite the adoption of structural reforms in both Ghana and Nigeria, policies which encourage land degradation remain. Such policies range from outright encouragement of inappropriate practices to indirect support as a result of poor land use planning and regulation. Some of the policy failures which have been noted over the recent past include:

- inadequate planning of road construction, mining, and urban development is a major source of gully erosion in south-eastern Nigeria and parts of Ghana;
- stumpage has not been charged on fuelwood harvests in either country, thus encouraging overexploitation, particularly for urban markets where alternative fuels are available;
- subsidization of fertilizers in Nigeria (now terminated in Ghana) has served to encourage substitution of inorganic nutrients for organic matter and more sustainable forms of fertility enhancement;
- mechanization and large-scale farming, which lead to widespread land clearing and greater soil disturbance, have been subsidized in both countries; and,
- an administered price for wheat in Nigeria, at several times its import parity value, encouraged the conversion of prime wetlands and valley bottom grazing areas to inefficient irrigated production.

Source: Knowler (1994); FAO/IC 1990 and 1991

2.7 Panayotou (1990) provides a synthesis of the market and policy failure explanation of resource degradation, and his approach is illustrated in Figure 2-1. This view posits that degradation results from the combination of economic and population growth, which stimulates increasing demands for resources, leading to increasing resource scarcity and eventual resource degradation. In the neoclassical view, degradation occurs because unregulated markets fail to pick up signals of impending resource scarcity or because of deliberate policy actions. Furthermore, correction of the problem is not integrated into decision-making by either individuals or governments. As an illustration, lack of information about changes in the resource base (a market distortion) may allow rising yields from improved cultivars and other agronomic changes to mask underlying soil degradation, making recognition of the problem difficult (Barbier and Bishop 1995). There is some evidence for this process occurring in Ghana, as a result of the many cropping packages promoted by government and NGOs in the early 1990s (FAO/IC 1991). For the reasons cited above and others, self-correction of degradation will be unlikely, and this is further exacerbated by gender and technical factors. For example, non-owners of land and trees in West Africa have little long term interest in improvements, while men are often unwilling to make land-related investments which will benefit primarily women (Francis 1987).

Figure 2-1
Policy and Market Failures in Relation to Increasing Resource Scarcity and Environmental Degradation



2.8 If by definition self-correction will not occur, then there is a need for government intervention. A lack of political will, combined with policy failures, may inhibit the government response and may even exacerbate the situation, such as when agricultural prices are kept inappropriately low to benefit urban consumers (see Sahelian country examples in Chapter 3); or state land ownership and control of public lands is not enforced, leading to *de facto* open access (see examples in Chapter 5). Thus, a reversal of the market and policy failures, or what can be termed market and policy successes, are seen as the key to rectifying the situation. While a useful paradigm, this approach can be faulted for not recognizing the complex interactions between physical resource attributes, population, poverty and environmental degradation, nor the presence of feedbacks which 'close the loop' and help explain why the degradation problems of Sahelian countries have not responded to the many efforts (and expenditures) devoted to them. These aspects, which are at the core of more recent thinking on the topic, are the subject of the next section.

B. POPULATION GROWTH, MIGRATION AND POVERTY LINKAGES WITH DEGRADATION

2.9 Market and policy failures are certain to be implicated in much of the land degradation and desertification (of human origin) occurring in Sub-Saharan Africa, particularly the latter. However, a consensus is emerging with respect to the role that additional factors, such as population growth and poverty, play in the process. Rather than being seen as isolated causative factors leading to overexploitation of natural resources, their function is seen as more complex and cross-cutting. In later chapters, we are concerned with how these factors mediate and intensify the influence of indirect incentives on household NRM decisions. Here we present a more general discussion of their role in the degradation process, and how they might act as incentives affecting NRM on their own. We also concentrate on the importance of these factors in the degradation of farming and grazing systems, largely ignoring the sizeable empirical literature on their linkages with deforestation.

2.10 At the core of the more complex view of the degradation process is a recognition that several key factors interact in ways which create feedbacks and thereby either intensify the process or lead to improvements which help to mitigate it. As discussed earlier, physical attributes -- that is, the nature of fragile and vulnerable agroecosystems such as those of the Sahel -- combine with unfavourable population and economic factors to create conditions for environmental degradation. Furthermore, environmental degradation may interact, via feedbacks, with these other factors to worsen the situation. It is the so-called nexus of these factors which Cleaver and Schreiber (1994) have described as the reason for Sub-Saharan Africa's poor performance on agricultural, population and environmental matters and for its continuing downward spiral. Pearce and Warford (1993) illustrate some of these relationships in Figure 2-2, where they distinguish pathways to degradation involving resources currently in use from pathways based upon 'frontier' resources. Here, population growth sets up both negative and positive feedback effects which are linked to poverty via changes in resource use; some of these feedbacks may lead to degradation of the underlying resource base. For example, the transfer of inappropriate agricultural technologies and farming of unsuitable lands in frontier areas can cause impoverishment which then ensures migrants cannot return to their points of origin, thus establishing a spiralling process of degradation and poverty.

Figure 2-2. Links Between Population, Environment and Poverty

Box 2-2 The Green Revolution in Africa: Market Driven Intensification or Boserupian Response?

The introduction of high-yielding varieties (HYVs) and a broad set of mutually reinforcing changes in agricultural practices have transformed the areas affected by green revolutions in Africa. The changes have typically involved a range of new technological components, including new crops, fertilizers and new power sources. Altered land patterns and changes in the labour economy have followed and facilitated the move towards either intensification or extensification of agriculture, resulting in substantial increases in regional output and income. Goldman (1993) argues that population growth and increased market access generate very different regional outcomes from agricultural change, while Smith *et al* (1994) concur that population-driven and market-driven intensification are fundamentally different, resulting in different economic conditions.

Population-driven intensification, based on Boserupian responses to population pressure, is characterized by:
- low farmer incomes;
- declining soil fertility;
- minimal use of fertilizer and other modern purchased technologies.

Market-driven intensification, where profitable crop production is the driving force, is characterized by:
- increases in farm income;
- substantial expansion and diversification of technology.

It is highly unlikely that the two types of intensification occur in isolation. Elements of both would exist within agricultural transformations occurring in Sub-Saharan Africa today. Furthermore, in areas with very sparse populations, fallowing is still viable and inexpensive as a means of fertility management, leading to the argument that there may be low demand for fertilizers and HYVs in these places, resulting in lower levels of agricultural change (Pingali *et al* 1987).

Goldman and Smith (1995) find that agricultural transformation can also occur in areas of relative land abundance, implying that remoteness, poor soils or climate and disease factors instead may inhibit major agricultural change. In Africa, their effect may be difficult to distinguish from that of population density. They conclude that: "rather than population *per se*, it has consistently been the constraints and opportunities of market-oriented production that have governed the dynamics and locations of these changes." Goldman and Smith (1995) make the further point that although innovation was present in the areas they studied: "...the continuation of the process of change, ... and certainly its rapid acceleration, were not inevitable. In the absence of new technology or in the face of major infrastructure constraints, unfavourable economic conditions, or highly exploitative government policy, stagnation rather than transformation would have been the more probable result."

2.11 Jha *et al* (1993) have identified some similar factors at work in parts of Asia, but there the 'nexus' problem is less pronounced or not present at all. In part, the reasons for Asia's success have been better functioning feedback mechanisms. The primary feedbacks of interest are associated with the demographic transition and the process of induced technological change. The former refers to a process whereby mortality rates decline in response to medical advances and then stimulate a lower demand for children, leading eventually to lower population growth via reductions in birth rates. The latter is concerned with the intensification of agricultural systems -- that is, technologically led increases in output per unit of land -- in response to endogenous factors, including population growth (these topics are discussed further in later chapters). Stemming from the work of Boserup and others (see Box 2-2), the belief is that these feedback effects act in concert to fend off the Malthusian prospect of declining per capita food production, or the need to draw down natural capital (resource degradation) to maintain production. Barbier and Conway (1993) discuss how this goal was attained in Asia, at least in the short term, since the longer term sustainability implications of the 'green revolution' are a cause for concern.

2.12 In Sub-Saharan Africa, the working of these feedback mechanisms has not been as pronounced, and they hardly seem to be present at all in some cases. Some arguments hinge around much lower population densities, which inhibit the induced technical response to rising populations, i.e. there is little incentive to intensify if land pressure is not high (Sinn 1988; also see Box 2-2). Table 2-1 demonstrates that indeed crude population densities, defined as total land area over total population, are much lower in the Sahel, in comparison to other countries and regions. However, when instead arable land per capita is used, the differences are much less pronounced: West African averages lie between a range defined by India and China, although admittedly they rest near the top of the range. Yet there can be little doubt from the first two columns of Table 2-1 that demographic transition has not occurred in West Africa, or indeed in Sub-Saharan Africa generally, so that other factors are likely to be at play as well. Cleaver and Schreiber (1994) argue that the speed at which population growth rates have risen in Africa has been a key inhibiting factor, since there has been inadequate time for the appropriate demographic and technical responses to develop. In the European and even some Asian situations, population densities have risen over much longer periods, allowing time for the necessary changes in family planning and agricultural practices to take hold. Box 2-2 discusses some additional views on the process of agricultural transformation in Sub-Saharan Africa, indicating some of the complexities involved.

2.13 Serra (1996) adds several additional arguments relevant to the African case. First, we can observe that induced technical change requires supporting advances in research and then the possibility for information about these opportunities to be transmitted via extension systems. If these supporting institutional developments do not occur, or are inadequate, then the process may not occur as predicted. In some cases, where sustainable intensification practices are not introduced, inappropriate practices have been simply transferred from established croplands or grazing areas to marginal lands, leading to degradation. While Sahelian Africa has been as prone to this problem as any other region, Southgate *et al* (1990) argue there have been some successes, such as French development efforts involving cotton in southwestern Burkina Faso. Second, some West African agroecological systems may not be capable of intensification, because of poor soil resources and other physical-climatic factors. In such cases, increased demands placed on the system to meet growing food needs may simply lead to degradation. Data on the extent of land degradation in the Sudano-Sahelian zone of Africa, quoted in Chapter 1, tend to support this hypothesis.

Table 2-1 Indicators of Population Growth and Land Availability, West Africa

Countries	Population Growth 1990-1995 (%)	Total Fertility Rate 1990-95	Population Density 1990 (ha/person)	Arable Land per Capita 1990 (ha/person)
Sahelian Countries (CILSS)				
Burkina Faso	2.79	6.50	3.03	0.40
Chad	2.56	6.03	22.70	0.56
Gambia	2.88	6.50	1.26	0.20
Mali	2.87	7.06	14.71	0.23
Mauritania	2.69	6.80	52.63	0.10
Niger	3.12	7.18	16.39	0.47
Senegal	3.04	6.50	2.66	0.71
Average (unweighted)	2.85	6.65	16.20	0.38
Other West African Countries				
Benin	2.97	6.20	2.38	0.40
Cameroon	2.87	5.85	4.04	0.59
Côte d'Ivoire	3.54	6.61	2.70	0.30
Ghana	3.09	6.10	1.61	0.18
Nigeria	2.87	5.86	0.96	0.29
Togo	3.32	6.50	1.57	0.40
Average (unweighted)	3.11	6.19	1.80	0.36
Sub-Saharan Africa (total)	2.99	6.24	4.70	0.29
India	1.81	3.74	0.39	0.2 (1987)
China	1.44	2.37	0.84	0.4 (1987)

Source: Cleaver and Schreiber 1994

Population Growth

2.14 Some aspects of the so-called nexus problem warrant further discussion, beginning with the influence of population growth on the degradation process. Population growth is largely rooted in the micro-decisions made by millions of individual households with respect to their survival strategies and social milieu (see next section). Decisions made by African women concerning their own fertility are a key mechanism by which the demographic transition functions. Large families may be desirable for a number of reasons, such as to provide labour, social security and as a response to the inferior social status of African women vis-à-vis men (Pearce and Warford 1993). In addition, having just a few children and then investing scarce savings in educating these can be a high risk strategy, given the high child mortalities and limited employment prospects of most African countries. Most research in this area has demonstrated that educating female children has the greatest impact on reducing fertility rates, so that investing in the education sector is liable to have a positive indirect incentive effect. Other incentives operating at the household level are discussed in the next section.

2.15 Bilsburrow and Ogendo (1992) see land use change as the key intermediary between population growth and degradation, citing the following four phases through which the process may work:

- tenurial, reflecting adjustments in tenure to accommodate population increase;
- extensification, including the development of frontier regions and rural-rural migration;
- technological, covering intensification and the adoption of new farming techniques; and
- demographic, referring to the demographic transition, as described earlier.

2.16 These phases may occur concurrently or in sequence and may interact in various ways, so that their linkages are liable to be complex. For this reason, population growth is often thought of as a 'compounding' factor with respect to land degradation, rather than being seen as having a one-way causal influence (Barbier and Bishop 1995, Pearce and Warford 1993).

2.17 Degradation need not necessarily result from population growth, as the latter may lead to greater sedentarization and infrastructure development, consequently reducing some of the incentives for keeping large families (Pearce and Warford 1993). However, if population pressure does lead to declining land productivity, this may create further feedbacks which can exacerbate the situation. The demand for labour can increase as labour is substituted for deteriorating land or forest resources, thus setting up a vicious cycle of increasing population and degradation. Cleaver and Schreiber (1994) test this hypothesis against national data on total fertility rates and various measures of land pressure in Africa and find the data support it. Increasing land pressure also alters the relative factor endowments of households as degradation proceeds, i.e. there is a reduction in the productivity of their land and a corresponding increase in available labour resources. Such a situation has implications for the way in which indirect incentives will influence NRM; the attractiveness of various conservation measures will change.

Migration

2.18 Large-scale movements of people, seasonally and semi-permanently, have been a characteristic of many West African countries. This form of labour market adjustment was earlier aided by various bilateral agreements amongst West African countries and with European countries like France. More recently, a negative perception of migration has led to efforts to restrict movement via investment projects in rural areas, registration by migrants, border controls and expulsions, with varying degrees of success (SOS Sahel 1995). Sinn (1988) notes that 25-30% of Burkina Faso's population resides in Côte d'Ivoire, and about half of these are employed in the agricultural sector. Large numbers of Fulani and other transhumant pastoralists predominate in large tracts of the Sahel (Riesman 1989). In contrast, data for Ghana suggest relatively low rates of rural-rural and rural-urban migration, at only 14.1% of all migrants in 1988, compared to 35.1% in Côte d'Ivoire (1986 data). For Botswana, the comparable figure using 1985 data was 89% (Bilsburrow 1992). Migration represents a more immediate response to population pressures than changes in fertility rates, but can have similar cross-cutting effects with respect to degradation. For example, it may constrain labour supplies in the source region and reduce the incentive to invest in labour-intensive soil conservation technologies, but at the same time localized pressure on land may decline.

Box 2-3 Migration, Women and NRM in the Sahel

In a study of 25 villages across four Sahelian countries (Senegal, Mali, Burkina Faso and Sudan), SOS Sahel (1995) examined the household level consequences, particularly for women, of seasonal and semi-permanent male outmigration. Their main conclusion was that generalizations about migration and its impacts on women's abilities to undertake NRM improvements are difficult to make. Migration has diverse forms, depending on the proximity of urban areas (e.g. Senegal), whether males alone or women and whole families migrate (e.g. Mali) and a host of other factors. It was also evident that sometimes NRM is affected while at other times not. One surprising conclusion was that lone female-headed households are rarely created as a result of male outmigration -- instead, female-led families often move into extended family compounds and receive the support of the compound head and other family members. This avoids the creation of 'vulnerable' single parent families, but results in women and children being a greater share of the remaining workforce.

The impacts on NRM are ambiguous, not least because in most study areas women previously had relatively little decision-making power concerning NRM and only occasionally assumed additional responsibilities once their husbands departed. In Senegal, males return often enough that they can continue to assume the responsibility for deciding about NRM, while in other cases the mantle of responsibility for NRM simply passes to the reigning compound head, who is typically an older male who does not migrate. In Mali's Dogon region, women maintain their own farm plots and continue to cultivate these as a priority in the face of male outmigration and there is relatively little impact on NRM, as a result. Labour shortages are rarely created locally, but this depends on whether land or labour is the constraining agricultural input, with a noticeable continuum running from the former to the latter as one moves eastward from Senegal. At the same time, male outmigration appears not to reduce land pressure since other family members or villagers step in to farm any land freed up. There was no discernible improvement in fallow periods as a result. Similarly, remittances provided by male migrants were rarely applied to agricultural improvements, except in Mali where less land pressure and a more feeble cash economy created greater incentives.

Instead it is often factors other than migration which impinge on decisions about NRM and, in any event, women are usually not the instigators of improvements (e.g. Senegal), except in Burkina Faso where they are highly integrated into soil and water conservation activities. Thus, the study concludes that there are no 'overwhelmingly' positive or negative implications for women's contributions to NRM from male outmigration. Nonetheless, seasonal or semi-permanent male migration remains an important survival strategy and doubtlessly without it there would be a greater food shortage.

Source: SOS Sahel 1995

2.19 Earlier development studies concentrated on rural-urban migration, modelling this as a function of differentials in wages and unemployment rates (as a proxy for employment opportunities) and of migration costs (Meier 1976). Standard hypotheses predicted that migration would increase in response to an expected net gain in income from doing so, which demonstrates the importance of both push and pull factors (Swanson 1996). Similarly, Jaganathan (1990) suggests that rising rural literacy (push factor) and improving urban infrastructure (pull factor) also encourage rural-urban migration. By reducing land pressure and providing remittances to support rural incomes, such migration would have an expected positive impact on NRM in rural areas, while for the receiving urban environments the impact would be the reverse. Thus, policies to encourage the push and pull factors behind rural-urban migration may create positive incentives for rural NRM, but only if labour shortages do not develop in the source areas, leading to an inability to maintain the natural resource base. Some of the substantial implications -- and ambiguities -- of this form of migration for women in the Sahel are discussed in Box 2-3, and further explored in Chapter 3. A useful review of the various theories of migration decision-making at the household level is provided by Gallup (1997).

2.20 Much of the current concern about rural environmental degradation and migration is focused on rural-rural migration, particularly in 'frontier' areas, where environmental damages are liable to be profound (Southgate 1990). Examples outside of Africa include large-scale deforestation in the Amazon (Binswanger 1989, Mahar 1986), the transmigration schemes in Indonesia (Mikesell 1992, Jha *et al* 1993) and settlement of the Terai region of southern Nepal (Shrestha 1989). In West Africa, frontier-type migration phenomena have included movements of cocoa growers into the high forests of western Ghana and eastern Côte d'Ivoire, in response to poor incentives for rehabilitation of existing cocoa lands outside the forest zone (Benneh 1988). Success with eradicating *onchocerciasis* in the more humid Sudano-Guinean Zone of West Africa stimulated flows of migrants from the more populous and arid northern areas into this region, as occurred in the Nepal example where the elimination of malaria was the precursor. Long-term shifts in the migratory patterns of African pastoralists in response to the control of tse-tse could also fall into this same category.

2.21 In some cases, frontier migration is a response to intentional policies which encourage resettlement via a system of favourable tax, credit and other incentives, including infrastructure development and low-cost agricultural land (Pearce and Myers 1988). In more extreme cases, such as Indonesia's transmigration scheme, there is an element of coercion. In a controversial paper, Sinn (1988) looks at the role of development policies in the Sahel in terms of the incentives created to migrate or remain at home, arguing that policies designed to maintain populations at levels beyond local carrying capacities harm NRM and that in the absence of such policies there is evidence of migration. Thus, he sees the persistence of poverty in the Sahel as policy-induced and argues for encouraging migration to more productive southern regions by limiting aid during droughts. In the end, policies and economic incentives are undoubtedly a critical factor in making the decision to migrate, or in deciding upon a destination, as demonstrated empirically by the lowland-upland migration model for the Philippines constructed by Cruz *et al* (1996). Bilsburrow (1992) further points out that the presence or absence of return rights to land affect the desire to migrate and its permanence once a move takes place.

2.22 Impacts on NRM from rural-rural migration depend upon whether the focus is on the origin or destination and may be positive or negative. Southgate (1990) points out that frontier settlement almost always incurs substantial degradation through excess land and forest clearing, often in response to legal provisions granting land rights (see Figure 2-2). Cleaver and Schreiber (1994) argue that migrants may bring agricultural technologies with them that are suited to the

agroecological system they have departed but poorly adapted to the destination's resource base, leading to possible degradation. A broader perspective may also be important in determining the environmental impacts associated with migration. Migration may be one of several possible responses to shocks or declining income opportunities, with the other alternatives including intensification of existing lands, seeking of off-farm employment or the development of other income-generating activities. Whether migration leads to a net deterioration in natural resource conditions depends upon what other alternative response are available to households and whether these are more or less sustainable. Clearly, changes in indirect incentives can radically alter the relative attractiveness of the options.

Poverty

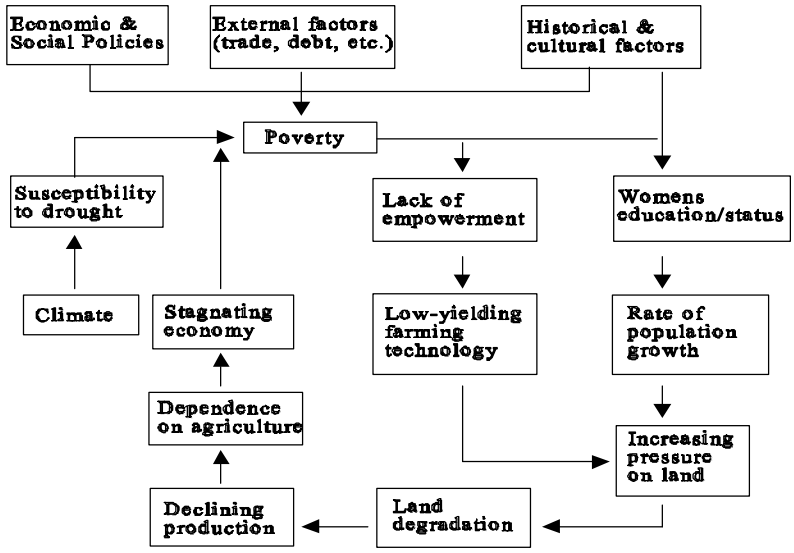
2.23 The location of poorer households or communities and marginal, degraded environments often coincide, and this is particularly true of the Sudano-Sahelian zone of Sub-Saharan Africa (Perrings 1996, Holmberg 1991). Thus, there is reason to assume some linkage between poverty and environmental degradation and, indeed, poverty is often implicated in the process of environmental degradation itself. However, the relationship is not necessarily a straightforward cause and effect situation. For example, Pearce and Warford (1993) refer to poverty as a 'disabling' factor, arguing it may accentuate pressures on natural resources but more importantly it may prevent appropriate responses which lead to sustainable use. Swanson (1996) argues that there is often some destabilizing factor at the root of a poverty-environment situation, and that the resulting incentives to degrade natural resources follow from the conditions of poverty and generate a vicious cycle of further poverty and degradation. Poverty is also linked with political power and asset distribution, so that exploitation of marginal lands by the resource poor may be the result of a lack of political recognition of their plight and the limited range of lands available to these sectors of the population. The linkages between poverty and incentives for improved NRM are clearly complex and not easily dissected.

2.24 We can conveniently divide the discussion on poverty-environment links into two approaches, one focusing on the poverty-degradation trap induced by limited options and a need to 'mine' the resource base in order to survive, and arguments seeking a more complex explanation for the interaction between poverty and the environment. Incentives issues are more intrinsic to the second line of reasoning, but the preceding argument, which hinges on the notion of a vicious cycle of poverty and degradation as a process of 'cumulative causation', is more widely cited. In this latter case, illustrated in Figure 2-3, the key incentives issue is the presence of poverty itself which works as an incentive for poor NRM. Thus, by alleviating poverty through programmes targeted at the individual or household (e.g. credit programmes, price supports) or at entire communities (e.g. literacy, health, market access, physical infrastructure) there is a spin-off benefit for NRM. We consider this line of reasoning in more detail below.

2.25 Under the 'cumulative causation' argument, the poor's meager wealth or 'asset depth' and limited income options, leave them less able to buffer shocks which may threaten their livelihoods. With fewer options to weather changing circumstances, the poor must either stay on and degrade their limited resource base, or migrate, as noted above. Often this resource base may be subject to open access, as the poor are disproportionately dependent on such resources, so there is even more incentive to degrade this natural capital (Rogers 1996). For example, Table 2-2 shows the poor's share of total income stemming from village commons versus that of the non-poor for a selection of household commodities in seven Indian states. However, the assignment of

property rights can have perverse impacts on NRM by alienating the poor if they do not benefit from institutional changes commensurately (see examples of this in Chapter 5).

Figure 2-3
Poverty-Environment: The Process of Cumulative Causation



Source: Holmberg 1991

Table 2-2 Share of Total Income Reaped from Village Commons by Poor and Non-Poor Families in 7 States of India, 1984

Commodity	Share of Needs Met for Poor Families	Share of Needs Met for Non-Poor Families
Firewood	91-100	-
Total Domestic Fuel Supplies	66-84 70-90	8-32 11-42
Grazing Needs	10	-
Gathered Food		

2.26 An Ethiopian study demonstrates how this 'mining' of an open access resource base, induced by poverty (and population growth), leads to worsening degradation and poverty and, finally, to collapse of the farming system (Newcombe 1989). This process works via the breaching of the nutrient cycles characterizing Ethiopian agroecological systems. First, the poorer households reliant on collecting fuelwood and timber from open access forests overharvest the available supplies, leading to insufficient fixing of atmospheric nitrogen. Overgrazing and scavenging for fuel substitutes leads to further nutrient losses, as does harvesting and selling the remaining timber and fuelwood supplies to the burgeoning urban population. Crop residues and dung become replacement fuels and further reduce nutrient inputs to the soil, leading to declines in crop and livestock productivity. Soil erosion increases because of reduced cover and organic matter. Further pressures from urban markets for fuel and timber put more pressure on rural resources, and the system eventually collapses. Sutcliffe (1993) has applied this model empirically to the Ethiopian situation.

2.27 Off-farm income might be expected to mitigate some of the effects of poverty with respect to resource degradation, by providing not only income but greater flexibility for responding to shocks. Household surveys in various West African countries have found it represents from 20 to 64% of total household income, making it a significant component of rural livelihoods (Reardon 1995). By providing cash to purchase food or inputs to intensify production, or capital to invest in land improvements, Reardon's study finds off-farm income reduces the incentive for extensification onto marginal lands. However, this is not universal, occurring instead primarily where agroclimatic conditions and net returns are favourable. The presence of local credit markets can also encourage such 'reverse linkages', i.e. where non-farm income is reinvested in agricultural production improvements, by providing opportunities for savings. However, off-farm income is not always found to be complimentary to improved land management: it may instead be competitive. For example, if households find lucrative off-farm employment then they may be less willing to invest in land improvements if this provides lower net returns. Extra income may also go to hiring labour for clearing additional lands.

2.28 Bluffstone (1995) has shown in a model of a representative Nepalese village that the p resence of a low wage, but ever-present off-farm labour market stabilizes forest use and prevents 'spiralling' overexploitation of open access forests. Ultimately, it becomes too expensive in terms of the opportunity cost of labour to exploit forests beyond a certain threshold collection time, given the option of off-farm work. In contrast, when such a labour market does not exist, the system is no longer stable, particularly with respect to fodder use which appears more responsive to off-farm conditions. The presence of a low-wage sector is thought to have played a role in stabilizing the forest area in the Mid Hills of Nepal over the last few decades. Barbier (1990) cites

similar beneficial effects with respect to soil conservation in Java, where off-farm employment reduces the intensity of farming on more fragile lands. Parallels with the Sahelian situation, where seasonal outmigration to more southerly West African countries might be expected to reduce the pressure on fragile croplands, are obvious but are not fully verified by recent research (see Box 2-3).

2.29 In contrast, poverty-environment links may be more complex and rely on a more indirect relationship, with some authors even questioning the significance of a direct poverty-environment link (Reardon and Vosti 1995, Jagannathan 1989). For example, Jagannathan (1990) examines poverty-environment linkages in two Nigerian locations, where the World Bank's Agricultural Development Project (ADP) was present, but finds little evidence of a strong, direct poverty connection. Instead, he cites road development, government policies and market forces as having a greater influence on NRM. More generally, it is argued that the very poor lack access to sufficient resources and the necessary energy to constitute a real threat to NRM. In irrigation systems, it is often the poorest who must occupy the furthest extremes of the distribution system, receiving relatively little water and, consequently, having little chance of causing waterlogging damages through overwatering. Similarly, the type of environmental harm that can arise from the poorer segments of rural society is circumscribed by their limited purchasing power. Damages arising from the overuse of other purchased inputs, such as fertilizers and pesticides, is largely a wealthier farmer problem and not one stemming from NRM in poorer areas.

2.30 While poverty may be a proximate cause of degradation in many cases, the fault is argued to lie more with inappropriate policies which both induce poverty and establish an incentives structure which encourages poor NRM by poverty-stricken households. Heath and Binswanger (1996) emphasize the joint effect of bad policies in causing losses in economic efficiency, increasing poverty and natural resource degradation. Together with Reardon and Vosti (1995), they show that a farming community may face divergent development paths, one involving appropriate Boserupian responses (see Box 2-2) and another characterized by a solely labour-led response to a land constraint, which is viewed as less sustainable.[1] They cite the examples of the Machakos District of Kenya (also see Box 5-8), where the former has occurred, and the Ethiopian Highlands, where the latter process has been associated with rural development. Poverty has been a factor in both cases, since appropriate policies allowed the farmers of Machakos to adopt sustainable agricultural practices as a way out of poverty and degradation (see also Chapter 5), while these have not been present in Ethiopia and persistent poverty and worsening degradation have been the result.

2.31 Inappropriate policies need not even be targeted directly at the poor to induce degradation by poorer households. In many countries, a 'large farmer bias' exists and manifests itself in an incentives structure which favours wealthier farmers and thereby accentuates poverty. The policy failures responsible for the situation create incentives for the rich and powerful to further marginalize the poor and restrict their access to resources, leading to greater pressure on those resources which are still accessible (Holmberg 1992, Heath and Binswanger 1996). Heath and Binswanger (1996) cite the case of Colombia, where public investment, credit policies and trade promotion have favoured large livestock producers and feedgrain producers at the expense of smallholders. Land and tax policies result in low intensity grazing occupying the fertile bottom lands best-suited to arable farming, while smallholders are pushed onto hillsides where farming

[1] We capture this idea of choices between alternative sustainable and unsustainable practices in the conceptual framework outlined in Chapter 1/B: "A Conceptual Framework for Assessing the role of Indirect Incentives" and illustrated in Figure 1-4.

practices are inappropriate and soils quickly degrade. As a result, there is the appearance that poverty is causing degradation, when it is instead the underlying incentives structure that has caused the problem.

2.32 In the end, Reardon and Vosti (1995) argue that less generalizing and more systematic treatment of poverty-environment links is needed, and this point may be usefully extended to incentives issues as well. For example, it may be necessary to differentiate the 'ultra poor', who are preoccupied with food security, from the somewhat better-off households more concerned with income security. Reardon (1995) differentiates these groups according to whether they are welfare-poor in the traditional sense, or investment-poor, implying they can meet daily needs but are unable to invest in land management improvements under prevailing prices and opportunities. Perrings (1996) adds that a lack of access to information is more characteristic of the poor and, combined with its importance in fostering improved land husbandry practices (see previous Chapter), this may further diminish NRM where poverty prevails. In both cases, poverty serves as a disincentive to better NRM. To the extent the income insecure succeed in diversifying income sources, they may put less pressure on the natural resource base. Jagannathan (1989) suggests that monetization and expanding market access may help this process, but Perrings (1996) cautions that by creating an 'open economy', producers become vulnerable to a whole new set of market-related shocks (e.g. international price fluctuations) which can destabilize the farming system and result in degradation. Similarly, expanding market access may favour élites and speed up the process of social differentiation in ways which further marginalize the poor and encourage mining of the resource base.

C. HOUSEHOLD DECISION-MAKING AND NRM

2.33 The aggregate level interactions and resulting outcomes for NRM described in the previous section are, in reality, the result of many micro-level decisions made by individual households. Thus, it is useful to consider what motivates these decisions as a prerequisite to understanding how indirect incentives might influence the process. To do this properly requires a review of the theory and evidence concerning behaviour at the household level, not just with respect to natural resources, but in a more general sense. We do not explore this topic here and instead relegate it to an appendix, as much of this literature is already well known to most readers. The appendix also discusses the link between indirect incentives, on the one hand, and NRM outcomes on the other: producers responding to the structure of incentives they face, choose strategies which lead either to sustainable practices or unsustainable ones. A description of this process is warranted early on, since the literature discussing the various incentives and their 'arms-length' impacts on NRM, reviewed in later chapters, largely bypasses this intermediate stage. We begin below with the importance of net returns in the adoption of NRM improvements and then turn to how other obstacles producers face in their everyday environment might inhibit improvements, despite good profitability.

Net Returns and NRM Improvements

2.34 Net returns from improved NRM are considered by many natural resource economists to be a primary consideration in household responses to land degradation (O'Mara *et al* 1988, Anderson and Thampapillai 1990, Barbier 1990, Barbier and Bishop 1995, Bojo 1996, Eaton 1996). Yet some researchers lament that this crucial aspect of NRM has not been investigated very often: Ostberg and Christiansson (1993) note that only about 10 to 15% of the papers presented at recent conferences of the International Soil Conservation Organization deal with the

benefits of soil conservation. Box 2-4 provides some definitions of the terms used in net returns analysis relating to NRM.

Box 2-4 Definitions in Net Returns Analysis of NRM

Net returns may refer to either the financial attractiveness of adopting conservation measures or constitute an economic analysis of the problem. A financial analysis takes the viewpoint of a private firm or individual and measures the benefits and costs they would consider. In considering improvements to NRM, these would consist of incremental revenues, as determined by market prices; production costs, such as wages paid to labour or for transportation, again using market prices; and taxes or subsidies. Thus, a financial analysis is concerned with actual monetary flows, either as revenues or costs. An economic analysis is instead concerned with whether adopting conservation measures represents an efficient use of a nation's resources. This involves assessing the opportunity costs of the technologies or management practices in question, including any off-site environmental benefits. Moreover, we must extend the analysis to consider benefits or costs for which no market price may exist. Even where market prices are available, these might need adjustment because of government intervention in the economy. Whether a financial or economic perspective is adopted, the analysis is usually undertaken within a cost-benefit framework. The presence of market failures is associated with a divergence between financial and economic profitability, and accounts for the possibility that farmers may not invest in improved NRM, even though it may make good sense from the nation's viewpoint. Such a divergence is a manifestation of market failure at the household level, as noted in earlier sections.

2.35 Despite concerns about inadequate attention to the profits from soil conservation, a number of authors have examined the profitability of improved NRM and we review some of these studies below. In most cases, a deterministic approach is taken, that is, risk is not implicitly accounted for, so that assessing the attractiveness of soil conservation from the perspective of the risk-averse farmer is difficult. However, many models can take account of a wide range of indirect incentives, since they explicitly include variable incentives such as prices, wage labour costs, exchange rate effects, taxes/subsidies, etc. and can allow for enabling incentives through discount rates, technology, etc. Thus, an assessment of the net returns from conservation can capture a wide range of indirect incentives effects, but stipulates that these influence behaviour only through their impact on profitability. An ODA/FSG study presents a proposal for a particularly wide-ranging and complete net returns model, incorporating yield trends, intensity/stocking rate, investment, land rights, price trends, variability, poverty and time preferences (ODA/FSG 1996). Such a model captures most of the indirect incentives discussed in the following chapters but, as is evident from the final net returns statement, is very complex. Simpler models have been used by most of the authors cited above and in the empirical studies reviewed below.

2.36 When a basic cost-benefit analysis framework is used to assess net returns, it can only tell us whether the proposed level of investment in NRM or a fixed change in management practices will generate a positive or negative profit. While suitable for project analysis purposes (as these usually involve well-defined levels of activity), this approach does not tell us whether this constitutes the maximum profit available from investing in NRM. In keeping with the notion of the 'optimizing' farmer (see Appendix), we may wish to know whether increasing or decreasing the proposed level of conservation activity will increase profits and thereby represent a more attractive proposition to the farmer. Given the dynamic nature of natural resource degradation, a dynamic optimization approach is preferred for such an analysis.

2.37 Although the mathematical complexities of dynamic optimization techniques prevent all-inclusive modelling of the sort envisioned in the ODA/FSG study, a number of theoretical studies have used this technique to assess the optimal level of soil conservation under conditions of changing indirect incentives. For example, Barbier (1995) presents a relatively simple optimization model of farm household decisions concerning soil conservation, based on McConnell (1983); Barrett (1989) applies these techniques to optimal rangeland use and later examines the role of agricultural price reform within a similar optimal soil conservation framework (Barrett 1991); and Grepperud (1995, 1996 and 1997) considers a range of policy issues influencing optimal soil conservation choices at the farm level, including prices and government/international assistance, as well as risk. Space limitations prohibit the further discussion of optimization techniques applied to NRM but, where relevant, the results of these studies are reported in later chapters.

2.38 We turn now to the empirical analysis of net returns, and provide a brief overview of several studies. Of primary interest in reviewing these studies is the extent to which conservation pays, either in economic or financial terms (see Box 2-4). A number of project-specific studies are available, but are primarily concerned with a single or very few management improvements. Bojo (1992) reviews 20 such studies, five of which involve African locations, and finds that despite some differences in approach most studies find soil and water conservation to be profitable, except where large, capital-intensive and top-down approaches have been used. With respect to incentives, he notes that "the important role of macro-economic policy as a backdrop for conservation efforts is clearly pointed out; agricultural pricing policy, access to credit, marketing regulations, land tenure and exchange rate policies all affect conservation" (p. 202).

2.39 Of perhaps greater interest are the West African and Central American/Caribbean, studies described in Table 2-3, all of which involve the screening of a range of possible conservation technologies. This approach gives a more representative picture of the household decision-making problem regarding soil and water conservation, as most farmers are faced with many options for modifying their farming practices in response to degradation, and must choose from amongst these possibilities. Where available, both financial and economic rates of return from adoption of improved NRM are shown. The results reported in Table 2-3 indicate that profitability can vary widely, so that although some measures may be attractive in a net return sense, many are not. Moreover, there may be evidence for a divergence between financial and economic rates of return, signalling the presence of market failure. Box 2-5 discusses the examples of Nigeria and Ghana (both cited in Table 2-3) where this problem may exist. Clearly, changes in indirect incentives could have quite different effects on the attractiveness of individual technologies available to farmers; in some cases, altering the benefit cost calculus but having little bearing on overall profitability, while in others switching net returns from positive to negative or vice versa.

Box 2-5 Net Returns to NRM in West Africa

Recent multi-disciplinary project planning work in two West African countries, Ghana and Nigeria, under the World Bank/Food and Agriculture Organization (FAO) Cooperative Programme (referred to as FAO/IC), assessed the farm-level incentives and the economic viability of a range of potential conservation measures, in light of the various market and policy failures present in each country (see Box 2-1). For Ghana and Nigeria, the FAO/IC team generated a list or menu of possible conservation technologies from which farmer participants could select options to address the various problems faced on their own land. Many of the measures considered came from the villagers themselves, or were under development locally, and needed only wider dissemination. After initial screening on technical and socio-economic grounds, 18 promising technologies were subjected to further analysis. Farm level models were developed for the various technologies, involving four major agro-ecological zones in each country.

When measured against even minimally acceptable financial rates of return such as 20 to 30%, which reflect rural seasonal interest rates, most conservation technologies appeared unattractive. In contrast, most appeared to meet the economic efficiency criterion of at least a 10% ERR, once adjustments were made for the market failures responsible for the divergence. Conventional economic theory suggests that where there is a divergence between private and public interests, the payment of subsidies or incentives may be warranted. Given the size of the shortfalls in net returns calculated, some restructuring of farm level incentives was recommended to bridge the gap between the financial and economic attractiveness of on-farm conservation.

Source: FAO/IC (1990, 1991), Knowler (1994)

2.40 Several other African empirical studies concerned with the profitability of soil conservation should also be noted, including Bojo (1991), who examined the economics of land degradation in Lesotho, and two other case studies from Malawi (Barbier and Burgess 1992, Eaton 1996). In a study of the gum arabic system of Sudan, Barbier (1992) considers the economics of improving an existing management system with positive environmental effects which are not fully taken into account by farmers. This analysis makes the useful point that not all improvements to NRM involve the adoption of a new technology; indirect incentives may encourage competing but less sustainable cropping systems, i.e. groundnuts or sesame, at the expense of those existing systems known to have positive environmental effects. Thus, policy support for the rehabilitation and maintenance of these existing, sustainable management systems may be required as well.

2.41 While the results reported in Table 2-3 concentrate on cropping system improvements, we can give consideration to the profitability of NRM on rangelands. For example, in Burkina Faso grazing land reclamation is said to provide a financial net return of CFA franc 9400/ha (US$ 31/ha) at a 10% discount rate, while in Nigeria resowing of grazing areas yields a financial rate of return of 7.1% and an economic rate of return of 8.5% (World Bank 1990, Knowler 1994). On the basis of these results, conventional range management appears to offer relatively low rewards, providing further impetus for the adoption of the more flexible management strategies discussed in earlier sections.

Table 2-3 Review of Financial and Economic Rates of Returns for Conservation Technologies, West Africa and Central America-Caribbean

Country (Source)	Conservation Technologies	Type of Analysis	Rates of Return (%)
West Africa:			
Burkina Faso (World Bank 1990)	Rock dams, organic fertilizer, chemical fertilizer, bunds, tied ridges and combinations in degraded and non-degraded areas	Financial	-23,525 to 21,627 CFAF/ha*
		Economic	-2.17 to 33.8
Nigeria, Northern (Anderson 1987)	Shelterbelts and farm forestry	Economic	14.9 to 19.1
Nigeria (Knowler 1994)	Stone lines, vetiver, bunds, stone terraces, afforestation, shelter belts, alley cropping, woody fallow, animal traction, fodder banks, woodlots, farm forestry, grazing rehabilitation	Financial	-2.1 to 21.7
		Economic	1.4 to >100
Ghana, Northern (FAO/IC 1991)	Mulching, ridging, strip cropping, stone lines, vetiver, woody fallow, animal traction, fodder banks, woodlots, farm forestry,	Financial	-18.5 to 22.1
		Economic	-12.6 to 34.9
C. America/Caribbean:			
Costa Rica, Dominican Republic, Guatemala, Haiti, Honduras, Panama (Lutz *et al* 1994)	Diversion ditches, terraces, ramp pay, rock walls	Financial	< 0 to 84.2
Honduras, Mexico, Nicaragua (Ellis-Jones and Sims 1995)	*Gliricidia, Vetivera, Pennisetum*, ditches, cover crops, stone walls, *Cajanus cajan* and combinations	Financial	< 0 to 50
Costa Rica, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Nicaragua, Panama (Current and Scherr 1995)	Agroforestry: agricultural intercropping, alley cropping, contour planting, perennial intercrop, taungya, woodlots	Financial	0.97 to 2.50**

(*) NPV at 10% discount rate
(**) average cost-benefit ratio at 20% discount rate

Other Factors Influencing Household Decisions about NRM

2.42 Adoption rates for some of the soil and water conservation technologies cited in Table 2-3 are typically quite low, even for some of the technologies demonstrating relatively high rates of return. For example, only 3 to 5% of farmlands in Burkina Faso's Central Plateau are reported to have benefited from anti-erosion measures, despite 10 to 15 years of interventions by government,

NGOs and donors (World Bank 1990). If so, then factors in addition to the profitability of NRM improvements may play a role in farm household decision-making about NRM. If it is true that when not constrained in various ways, smallholders will act rationally to preserve their livelihoods, then such constraints may be amongst these additional critical factors. The Appendix notes the importance of constraints in modelling household behaviour, especially labour allocation decisions within an agricultural household model (AHM) framework. Mortimore (1985) raises the importance of constraints facing Sahelian farmers, focusing on physical factors such as limited rainfall, scarce arable land resources, growing population and economic factors, such as price variations and shortages of labour and capital. Constraints may help explain why households allow their natural resource base to degrade and how they will respond to changing indirect incentives. Constraints may serve, therefore, as an important link between producer behaviour and NRM.

2.43 Economists grappling with this problem must first come to terms with the obstacles confronting the subsistence farmer who wishes to improve land management. Some of the constraints which may impinge on smallholders' choices about soil and water conservation include severe livelihood stress, including malnutrition or starvation; insecurity of land tenure; uncertainty surrounding future returns; low 'perceived' levels of net returns from conservation; and instability in the markets for inputs and outputs (Ellis 1993). In addition, many land management technologies have limitations from the farmer's perspective, beyond what may be implied by a low rate of return:

- they may require out-of-pocket costs which are unmanageable in light of rural credit market conditions, i.e. animal traction;
- they may demand large amounts of incremental labour which may not be available during key cropping periods, i.e. alley cropping, *Vetivera* grass strips;
- they may require inputs of organic materials which are simply not available in the quantities needed, either on-farm or regionally, i.e. manuring, mulching; or,
- they may remove land from production, either permanently or temporarily, thus actually reducing farm food production initially, i.e. fodder banks, alley cropping, *Vetivera* grass strips and bunding.

2.44 Lutz *et al* (1994) point out the over-riding importance of net returns to conservation activities, but qualify this with concerns about land tenure constraints. They make the valid observation that lengthy payback periods for conservation investments are suggestive of poor net returns. Yet it is primarily under these conditions that land tenure becomes an important determinant in the attractiveness of such investments, since security of use rights over a long period would be a prerequisite. As a result, it may be difficult to distinguish between poor returns and land tenure constraints as disincentives to NRM; ultimately, they may act in concert to discourage investment in conservation (see also Chapter 5).

2.45 While integral to net returns calculations, private discount rates represent an additional issue which can be linked to broader influences in the producer's environment. Most anecdotal and theoretical analyses suggest that high private discount rates predominate in developing countries, and that these are associated with worsening incentives for the adoption of improved NRM, whether this is meant as better land husbandry or investments in conservation works (Anderson and Thampapillai 1990). Since the benefits of many conventional soil and water conservation technologies develop over a period of time, in contrast to the need to incur up-front

costs, a higher discount rate implies a lower net present value, all other things equal. The length of the planning period over which such calculations are made may be important, since farmers can postpone adopting soil conservation until conditions deteriorate sufficiently for conservation to become attractive. As discount rates rise, this postponement period increases, leading Anderson and Thampapillai (1990) to argue that this period can become so long that the planning period becomes irrelevant and soil and water conservation is simply not attractive.

2.46 Several qualifications to the avowed principle of high discount rates and poor land management incentives can be raised. First, Larson and Bromley (1990), while concurring that discount rates are important, demonstrate that their impact may be dominated by other institutional factors. For example, they note that net returns under an open access property regime produce incentives equivalent to those under secure property rights where an infinite discount rate is assumed. Thus, high discount rates may be immaterial in the presence of institutional problems. Furthermore, in a dynamic optimization model of soil conservation, Barret (1997) shows that higher private discount rates result in a lower optimal soil depth but this is not unequivocal and there are plausible circumstances where they may have no effect at all. Second, newer thinking on the possibilities for improving cultural practices as an option to conventional conservation structures implies that up-front costs may be minimal and benefits may materialize almost immediately. In such cases, discount rates become largely irrelevant. Finally, there is emerging empirical evidence from the Philippines that high private discount rates are not always correlated with the absence of investments in land improvements (Lumley 1997). However, much more research is needed into this area before a rebuttal of the standard assumptions about discount rates and conservation can be made.

2.47 Tied to high discount rates is the presence of risk and uncertainty, since this is often identified as the cause of high private discount rates. Farm households face several types of uncertainty, including natural hazards, market fluctuations, and social or institutional uncertainty, the latter referring to land tenure problems, access to grazing lands, competition with farmers for land and exposure to conflicts and wars. While consistent with a net returns-profitability approach to improved NRM in some respects (Box 2-5), risk and uncertainty may affect decision-making in other ways too. For example, the discussion of the 'risk-averse' household model presented in the Appendix mentions the importance of disaster avoidance, which is more appropriately modelled using a 'minimax' strategy. The following implications are also usually associated with high levels of uncertainty in smallholder production systems (Ellis 1993):

- it leads to sub-optimal economic decisions at the household production level due to the absence of profit maximization;
- it results in a slowness or unwillingness to adopt innovations aimed at increasing expected or average outputs alone;
- its impact is more severe for poor than for better off households, leading to worsening social differentiation;
- it may either be reduced or increased with increasing market integration due to the contrasting effects of better information and sales opportunities with greater reliance on insecure markets and adverse price trends; and,
- it leads to production system adaptations or innovations which ameliorate the effects of risk, which has consequences for the adoption of soil conservation technologies.

2.48 The adoption of soil and water conservation measures entails risks, but then so may doing nothing, if this runs the risk of significant losses in productivity. Farmers may be prepared to take actions to avoid such losses in productivity as a means of risk reduction. For example, a survey of Colombian farmers who were unwilling to adopt modern and potentially erosive farming packages indicated that the main reason for rejection was fear of erosion-induced productivity losses (Reinhardt 1987). Nonetheless, it is more commonly accepted that changes in management practices to reduce degradation are perceived as risky. Poverty is liable to accentuate this view, since the lack of 'asset depth' cited earlier means that mistakes carry greater consequences for household survival.

2.49 Rangeland degradation is a source of risk and uncertainty for pastoralists as well, manifesting itself as greater vulnerability to physical and financial losses than if no degradation is present. We can understand how pastoralists might respond to this situation by considering a 'survival algorithm' (Livingstone 1986). This refers to the notional calculus employed by pastoralists in arriving at a minimum satisfactory herd size. Rather than employ an expected value-type approach, pastoralists are more liable to adopt a worst case scenario outlook in determining an appropriate minimum herd size. This will be based upon their subsistence and herd rebuilding needs in the event of a severe loss event. One aspect of this calculus is that a large number of stock in poor condition are preferred to a lesser number in better condition. That is, the quality of livestock is a lesser concern. This attitude is prevalent among both East African and Tibetan pastoralists (Livingstone 1986, FAO/IC 1993). The implication of the survival algorithm concept is that it requires us to look not only at the stocking rate, in judging indirect incentives and resource use, but the livestock to human ratio as well.

3. VARIABLE INCENTIVES AT THE SECTORAL LEVEL

3.1 In the previous chapter, net returns were seen as an important stimulus for changing producer behaviour, particularly if the opportunities for responding are not constrained in any significant way. In this chapter, we turn to variable incentives stemming from within the agricultural sector, and their role in causing changes in NRM, chiefly via their influence on net returns. These variable incentives might include agricultural prices, including tax and subsidy effects, as well as the influence of labour opportunity costs. Of particular interest is the effect of agricultural prices on NRM, a topic we will explore at some length because of the complex issues involved and the resulting problems with making generalizations. We will not just consider output prices, but extend the analysis to include purchased inputs, particularly fertilizer, pesticides, irrigation water and mechanized services. In this chapter, we set the stage for the subsequent consideration of various non-sectoral factors that can similarly affect NRM via their influence on agricultural prices. Obviously, policies geared towards raising output prices or reducing input prices can have the similar effect of raising net returns to producers from cropping or from investing in improved NRM in response to a perceived degradation threat.[1] Purchased input price changes may also have more complex effects, altering the relative attractiveness of the various possible responses to a NRM problem, as when fertilizer subsidies are decreased, thereby increasing the relative profitability of more sustainable fertility enhancement measures.

A. AGRICULTURAL PRICES AND NRM

3.2 In a market economy, prices serve the important function of signalling the relative scarcity of inputs and values of output so that society's resources can be allocated to production activities efficiently. As a by-product of this allocative function, agricultural prices may influence NRM in various ways (assuming the relevant prices exist), as earlier suggested by the study's conceptual framework (Figure 1-4). General price level changes at the sectoral level will have different effects than individual crop price changes. The outcomes for NRM will also depend upon whether price effects induce the adoption of sustainable cropping practices and conservation measures, or whether they encourage unsustainable cropping activities. Pastoral management is also influenced by prices, particularly those for livestock and grain, but has additional dynamic interactions to consider. Empirically, the relationship between agricultural pricing and supply responses has been analyzed by a large number of researchers (see Mamingi 1997), while the more specific linkage with natural resource degradation has been much less investigated (Barbier and Burgess 1992). As a result, we can hope to infer implications from existing research, rather than draw definitive conclusions, and in many cases no firm judgement can be made about price effects and NRM at all. A more detailed review of the empirical evidence regarding agricultural prices and NRM is provided in the Appendix to Chapter 3.

3.3 Analyzing the role of agricultural prices on NRM begins with the premise that these prices exist. For most primary outputs and inputs associated with cropping and livestock, market prices do exist. If they do not exist, yet these products are used as outputs or originate domestically as inputs, there is often a comparator price available from local markets or one may be inferred from the opportunity costs of foregone alternative uses. However, from a NRM viewpoint, the soil resource (both quantity and quality) represents a critical input to agriculture and yet there is no

[1] Even so, price supports and input subsidies have quite different effects on producer and consumer welfare, in the economic sense. See Tolley *et al* (1982) for a useful discussion of this topic.

market nor suitable opportunity cost available (Shuh and Archibald 1996). In the language of Chapter 2, which dealt with the causes of natural resource degradation, this situation constitutes an important market failure. Using a dynamic optimization model of soil conservation decision-making at the household level, Barbier (1995) derives a *shadow* or *implicit* price for the soil resource. He shows that since this price is not observed by the farmer, it is liable to be underestimated, leading to insufficient soil conservation.

3.4 Even though market prices exist for many agricultural outputs, if these prices are set by governments, then there is potential for a policy failure when these prices do not accurately reflect the true social value of production, as normally expressed by border prices. In Mali, Lele (1984) notes that in the late 1970s effective taxation of cotton reached 24 to 61% and on groundnuts it ranged from 48 to 65%, even after allowance is made for subsidies on fertilizer and credit. Several West African exports, i.e. cotton, cocoa and coffee, are marketed through inefficient parastatals which charge high margins, with the subsequent penalty imposed on producers amounting to an export tax (Lensink 1996). Table 3-1 presents data on official producers' prices (government-administered) for a variety of agricultural commodities exported from West Africa, in relation to the world reference price, an indicator of the revenues available from unregulated pricing. Movements in the ratio of these two prices over time suggest the situation has improved since the latter half of the 1970s, with distortionary gaps likely to have been declining over time[1]. Nonetheless, gaps are likely to remain, even if their exact magnitude is not revealed in the Table.

Table 3-1 Ratio of Official Producers' Prices to International Reference Prices, Western Africa

Commodity	Countries	Average 1975-79	Average 1980-85	Average 1986+
Cocoa	Ghana, Côte d'Ivoire, Sierra Leone, Nigeria	0.43	0.79	0.49
Coffee	Liberia, Togo	0.33	0.48	0.67
Cotton	Niger, Mali, Benin, Burkina Faso, Chad, Cameroon	0.46	0.41	0.61
Groundnuts	Gambia, Senegal, Guinea-Bissau	0.53	0.52	0.62
Palm kernels	Guinea	1.08	0.86	0.62

Source: Cleaver and Schreiber 1994

3.5 Distorted pricing of individual exportable commodities relative to other tradables and non-tradables has impacts on resource allocation and, consequently, on NRM. For example, inappropriate relative pricing can encourage the cultivation of erosive crops at the expense of less erosive ones (or vice versa, admittedly). It can also have more indirect impacts on NRM through the process of impoverishment which results from low, administered crop prices (Perrings 1996) the way in which the cross-cutting effects of poverty and limited 'asset depth' can lead to degradation is described in the previous chapter. Furthermore, indirect incentives effects occur with respect to distorted prices and technical change; the induced innovation model sees the structure of relative prices as a key determinant in the development of profit-enhancing production improvements. If price signals are incorrect, then research expenditures may be misdirected, leading to encouragement of the wrong crops (Lingard 1992). Schultz (1984) cites

[1] Since official producers' prices and international reference prices may not measure the commodity's value at the same point in the marketing chain, there may be no particular significance to a ratio of one. Instead, shifts in the ratio over time indicate improving or worsening effects of the policy failure induced by administered prices.

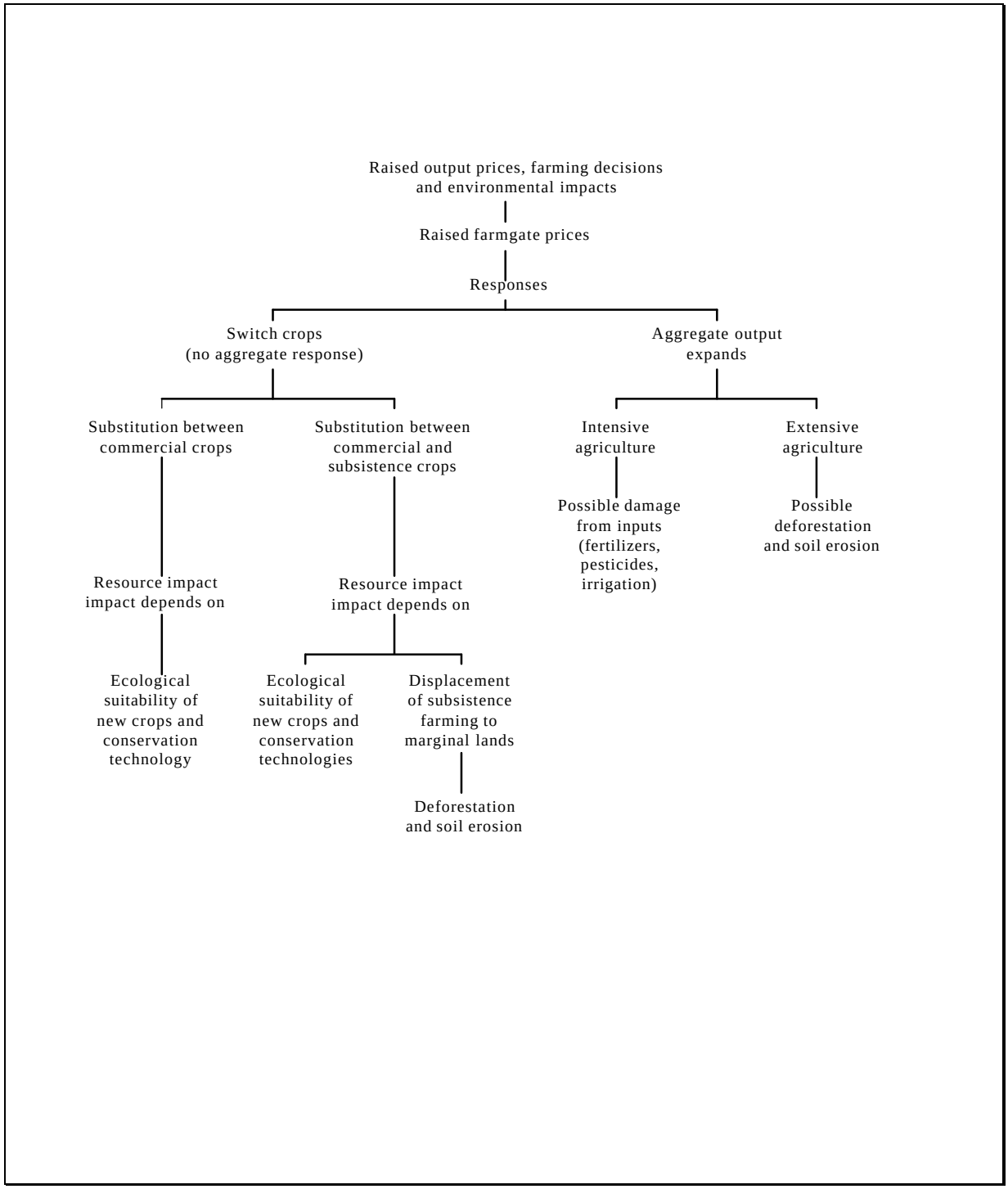
the overpricing of sugar beets in Europe and the U.S. and rice in Japan, as examples of where excess research was funded, while the artificially low pricing of rice in India is said to have had reversed consequences.

3.6 In addition to potential impacts on NRM arising from non-existent prices or distorted prices, shifts in market prices will also have effects on NRM. Barbier and Burgess (1992) suggest four key ways that price changes can have an impact on NRM:

- where changes in prices increase net returns, the higher profits encourage an *aggregate expansion* in agricultural production, either intensively or extensively;
- if relative prices change there will be an incentive to switch crops, possibly leading to the *substitution* of benign crops for more erosive ones, or vice versa;
- *variability* in prices can have an impact on decisions concerning NRM, because of the risks associated with price volatility;
- adjustments in profitability will have an impact on the long run incentive to *invest* in onservation measures and land management.

3.7 The authors discuss the various ways in which these different attributes of price changes may interact to generate conflicting signals to the producer regarding the attractiveness of conservation. In Figure 3-1, Cleaver (1985) outlines several possible routes by which the first two of the agricultural price change effects cited above, i.e. crop switching or aggregate output responses, might affect NRM. Nonetheless, the figure supports the notion that price changes do not affect NRM via simple predictable mechanisms and that, ultimately, NRM impacts will vary according to household decision-making criteria and site-specific physical, technical and institutional conditions. A contrasting viewpoint is presented in Box 3-1, based upon theoretical modelling of price changes and producer incentives affecting NRM.

Figure 3-1 Possible Environmental Impact of Raising Agricultural Prices



3.8 The third price effect cited above, price volatility, is associated with the risk and uncertainty of making changes in farming practices. Although we have already discussed this problem in the previous chapter, we can note here that it is sometimes combated using price supports. Thompson (1996) notes that price supports can become capitalized into land values, thus raising the price of land relative to other production inputs and inducing overintensification and the use of agrochemicals or excessive investment in irrigation. Barbier and Burgess (1992) point out that by reducing the riskiness of cropping, price supports may allow the adoption of crops with greater production risk. If these crops are more erosive then there would be a negative impact on NRM, although the reverse situation is also possible. Based on a study of producer prices and NRM in Malawi, Barbier (1991) concludes that *price risk*, as distinct from predictable seasonal and other price variations, reduces incentives to invest in land improvements, particularly where producers' circumstances are already characterized by production risks and food insecurity. Some price risk may arise from marketing bottlenecks attributable to a lack of government intervention in the Sahelian countries (Southgate *et al* 1990).

Box 3-1 Theoretical Modelling of NRM Responses to Agricultural Price Changes

In contrast to the view that pricing policies can have a major impact on incentives to control erosion and maintain soil fertility, Barrett (1991) finds this may not be the case. Using a theoretical model to analyze optimal levels of soil conservation based on McConnell (1983), he assesses the effect on profits from an unanticipated, permanent output price increase (see the discussion of dynamic optimization modelling in the previous chapter). The effect on profits comes about as a result of households choosing one of two behavioural responses: investing in soil and water conservation and thereby increasing production by retaining their soil resources, or intensifying existing practices so that both production and erosion increase. He shows that an increase in the output price leads to equal profits in either case, so that the price increase cannot be associated with an incentive to behave one way or the other.

Similarly, Barrett's model of soil fertility enhancement under a shifting cultivation system suggests that a rise in the output price "...increases both the benefits and the costs of a longer fallow period by precisely the same amount." (p. 184) .Thus, there is again no incentive to change fallow periods in response to a price change. His conclusions therefore contrast with those presented in the main text. There are many qualifications to Barrett's analysis, including quite different effects where purchased fertilizer is applied, and these should be considered when making comparisons. Grepperud (1996 and 1997) extends Barrett's approach to assess price effects and investing in fixed conservation structures, finding the effect of changing prices ambiguous with respect to NRM. In a separate paper, he considers soil conservation adoption in situations of uncertain prices; in this case, the effects of price changes depend on whether additional output is associated with higher or lower levels of soil degradation for the risk-averse farmer. The latter situation is consistent with the win-win types of improved land husbandry technologies promoted by Shaxson *et al* (1989).

3.9 We can take the analysis a step further by considering the erosive qualities of individual crops and the resulting impact on soil erosion from the behavioural response to a price change. Table 3-2 shows the vegetal cover factors associated with different crops for use with the Universal Soil Loss Equation in West Africa. Crops or land uses shown near the top of the table tend to be less erosive, while those further down are more erosive. Perennial cash crops (except tobacco), such as coffee, cocoa and palms are associated with roughly one-third the erosion risk of subsistence food crops such as maize, sorghum and millet, and much lower risks than annual cash crops like cotton and groundnuts. However, Barbier (1991) notes that crop mixes have important consequences for erosion risk as well. In an analysis of agricultural prices and NRM in Malawi, he considers cotton, tobacco, cassava and maize grown in monocultures as erosive, and inter- or relay-cropping of maize, groundnuts and pulses as non-erosive.

Table 3-2 Vegetal Cover Factors for Erosion in West Africa

Factors	Representative Annual Soil Loss a/
Dense forest or culture with a thick straw mulch	0.001
Savanna and grassland, ungrazed	0.01
Forage and cover crops (late planted or with slow development)	
First year	0.3 - 0.8
Second year	0.1
Cover crops with rapid development	0.1
Rice (intensive culture, second cycle)	0.1 - 0.2
Palms, coffee, cocoa, with cover crops	0.1 - 0.3
Cassava (first year) and yams	0.2 - 0.8
Maize, sorghum, millet	0.3 - 0.9
Cotton, tobacco (second cycle)	0.5
Groundnuts	0.4 - 0.8
Bare soil	1.0

Source: Roose (1977)
a/ Measured per unit of erodability defined for a standard bare plot of soil

3.10 If crop switching is the chosen response to a price change, it is clear that erosion risk may rise or fall, depending upon the crops involved, which one experiences the price change and whether the price moves upwards or downwards. In tobacco-growing areas, for example, the output response to a change in the producer price is quite strong (see Appendix to Chapter 3). As tobacco is typically a highly erosive crop (Table 3-2) and additionally requires large inputs of fuelwood for curing, there is an indication of a strongly negative degradation effect in such areas when the tobacco price rises, on the assumption that tobacco will displace less erosive land uses. Thus, output price increases in this case constitute a significantly negative indirect incentive for NRM. Unfortunately, it is not possible to be more precise about price effects than this, without site-specific studies. We can conclude, therefore, that output price changes do result in impacts on NRM, but that these will vary according to whether the change is for all crops at the sector level or for individual crops and, furthermore, the latter's effect on NRM will vary according to the criteria cited above.

3.11 Understanding the dynamics of prices and pastoral management requires a somewhat different framework. Figure 1-2 showed some of the complex dynamic aspects of the drought cycle and the coincidental movements in important system variables, i.e. livestock prices, forage availability, substitute grain prices and livestock numbers, which often characterize the cycle. Of great importance are the trends in livestock and grain prices at times of drought. There is initially a downward pressure on livestock prices, as pastoralists attempt to sell off animals in response to deteriorating range conditions. The reverse effect occurs with grain prices, as drought-induced crop failure leads to rising market prices. Since pastoralists often rely on selling cattle to purchase grain for consumption, drought worsens their terms of trade, in effect, reducing their real incomes via this compounding effect (Holtzman and Kulibaba 1996, Toulmin 1996).

3.12 The link between livestock sales, i.e. offtake, and livestock (and grain) prices is a key relationship in the calculus of herd management. An ambiguous response to higher prices can be reasoned; there are incentives to hold more livestock and reap rewards later, thus enjoying the higher value of these assets in the interim, or to sell now while the price is high and enjoy the additional income (some of the motivations for holding cattle are discussed in the Appendix to

Chapter 2). Some studies indicate that livestock supply elasticities are initially negative in response to price increases, as producers build up their herds (Binswanger 1989). Perrings (1996) concurs, citing evidence for Botswana which suggests the long run effect on offtake from livestock price increases is positive, but only after a period of restocking has occurred, and the effect is weaker where pastoralists have access to income from other sources. Elsewhere he concludes that under open access conditions, there is a clear incentive to increase stocking pressure in response to higher prices (Perrings 1990). Holtzman and Kulibaba (1996) see the solution to the grazing pressure-pricing problem as one of improving the efficiency of marketing and not price support interventions by governments attempting to smooth the extreme volatility in livestock prices.

B. SUBSIDIES ON PURCHASED AGRICULTURAL INPUTS

3.13 In this section we consider how subsidies applied to agricultural inputs such as fertilizers, pesticides, irrigation water and mechanization, affect incentives for the conservation or degradation of natural resources (Note: informal credit supply is covered in Chapter 5, along with other enabling factors). Such subsidies often benefit larger landholders more than smallholders, because of their additional financial resources and greater integration into the commercial economy (Heerink *et al* 1996). Moreover, subsidized agrochemicals are disproportionately applied to cash or export crops over subsistence food crops (Young and Burton 1992). These two factors suggest there are important distributional considerations in the subsidization of inputs, which in turn can have further implications for NRM.

3.14 A number of researchers have examined the impact of input subsidies on the environment, although most concentrate on direct subsidization (i.e. Repetto 1988, Southgate 1988). There may also be indirect subsidization of imported inputs arising from distorted exchange rates, tariffs, preferential foreign exchange allocations and other macro level policies (see Chapter 4); indirect domestic subsidization may occur through favoured taxation of manufacturing, feedstock pricing or transportation, credit and marketing margins (Repetto 1988). In addition, interventions in other sub-sectors can interact with input subsidies to enhance or diminish their impact on NRM. With the advent of Structural Adjustment, many direct and indirect subsidies affecting purchased inputs have been reduced or removed altogether (Reed 1996). Nonetheless, there is still an interest in analyzing such policies as many subsidies or other controls on prices remain in place, or may be reimposed in the future if SAPs are unsuccessful or too unpopular to maintain politically.

3.15 Subsidies are often considered as a bain of economic policy, since they involve considerable cost to taxpayers and lead to distortions in the economy. In theory terms, they alter relative prices and thus have an impact on resource allocation within the economy, with the potential results for NRM we have discussed in the previous section. Yet, subsidies may often be justified if they correct for market failures, i.e. internalize externalities, or achieve other worthwhile, non-efficiency policy goals. Roodman (1996) cites a number of principles which characterize good subsidies, such as the effective targeting of beneficiaries, an absence of lower-cost alternatives and the application of full cost accounting to assess their worth, including consideration of the environmental costs and benefits. In terms of purchased agricultural inputs, subsidies have often been justified on the basis of broad national development goals, like meeting food consumption needs from domestic production or for regional development purposes (Sampath 1992).

3.16 Although purchased inputs such as vaccines and veterinary medicines are used in pastoral production systems, they are of much less importance in comparison to cropping systems, leading us to concentrate on the latter in this section. Nonetheless, there may be implications for pastoral management from the use of subsidies on purchased feed, which substitutes for rangeland grasses. In North Africa, for example, highly subsidized grains have allowed livestock owners to maintain extremely high stocking rates in light of rangeland conditions, at times providing up to 40% or even 70% of feed requirements via purchased grain (Johnson *et al* 1995). As noted in Chapter 2, feedgrain prices are an important component in the drought cycle. If highly subsidized during drought periods, they can encourage overstocking during these periods and induce a cycle of degradation and further subsidies, until the latter become a permanent feature of the management system (Bayer and Waters-Bayer 1994).

Fertilizer

3.17 Fertilizer use is an important factor in NRM, but its role is not straightforward. We have already seen that many factors bear on the soil fertility status of a plot of land (see Figure 1-1). As its use directly affects soil fertility, fertilizer can contribute significantly to maintaining or enhancing land productivity if used efficiently and if not relied upon alone to do the job (Anderson and Thampapillai 1990). Indeed, we earlier identified sustainable forms of intensification, in response to mounting population pressure, as factors in reducing the potential degradation of the natural resource base. Barbier and Burgess (1992) cite the case of Malawi where fertilizer subsidies have been associated with increases in productivity and amelioration of poverty, even if their administration has not been well integrated into land management planning. On the Jos Plateau in Nigeria, inorganic fertilizers have been one component in a multifaceted response to population pressure and declining soil fertility, which has included the application of mixtures of ash, organic and inorganic fertilizers (Phillips-Howard and Lyon 1994). Inorganic fertilizers may also improve soil properties in ways that reduce runoff and soil loss (Logan and Lal 1990, Roose 1977). Moreover, modelling of fertilizer subsidies in Ghana shows that these may reduce extensification by increasing the productivity of existing cultivated lands (Alfsen *et al* 1997). In effect, subsidized fertilizer substitutes for land and thereby reduces deforestation and other potential degradation. How the subsidy is financed, e.g. displaced infrastructure investments or a tax on agricultural production, determines the wider impact of the subsidy on economic growth.

3.18 Fertilizers are not used as extensively in Africa as in Asia, for a variety of reasons (Table 3-3). Mortimore (1989) blames lower fertilizer consumption in Northern Nigeria on the poor responsiveness of local crop varieties and on low application efficiencies, while others cite shortages, rationing and marketing problems as responsible for sub-optimal fertilizer use (Repetto 1988, Barbier and Burgess 1992). Large subsidies placed on fertilizers have been the norm throughout Africa, rather than the exception. As Table 3-3 shows, even several decades ago, substantial subsidies were paid by governments to reduce the costs of fertilizer purchase at the farm level (comparable data of more recent vintage are not available). Repetto (1988) argues that through the 1980s the rate of subsidization remained high or even rose further, as countries tried to offset increasing feedstock costs. For example, the mid-1980s rate of subsidy in Burkina Faso was 36%, in Togo and the Gambia it was 60%, and in Nigeria it was a substantial 80-90%. More recently, structural adjustment policies have sought to reduce the level of subsidy (see further discussion of SAPs in Chapter 4).

Table 3-3 Estimates of Fertilizer Subsidization and Consumption Rates, West Africa

Countries	Rate of Fertilizer Subsidy 1968/69-1971/72 (%)	Fertilizer Consumption 1979/80 (0.1 kg/arable ha)		
		1970/71		1990/91
Benin	n.a.	36	77	38
Burkina Faso	n.a.	3	26	39
Cameroon	20.0*	34	47	31
Chad	n.a.	7	n.a.	18
Côte d'Ivoire	33.0*	74	165	97
Gambia	23.8**	n.a.	n.a.	n.a.
Ghana	28.0 - 38.4**	11	65	48
Mali	13.9 - 35.7**	31	69	73
Mauritania	n.a.	11	108	93
Niger	n.a.	1	5	3
Nigeria	50*	2	36	124
Senegal	27.4 - 47.8**	17	123	50
Sierra Leone	29.8 - 39.9**	17	46	20
Togo	n.a.	3	49	172
Sub-Saharan Africa	n.a.	33	59	90
India	25 - 50*	137	313	743
China	n.a.	410	1273	2777

Source: Repetto 1988; Cleaver and Schreiber 1994
(*) on all fertilizers (India varies by state)
(**) only on selected fertilizers

3.19 Even where subsidies remain, some studies have indicated that large portions of the subsidy on fertilizer intended for smallholders does not actually reach them. In Nigeria, Ranade (1990) has shown that at least half the total fertilizer subsidy was enjoyed not by farmers, but by the fertilizer industry, the transporters and the traders in the parallel market. For 1989, it was estimated that about 40% of the supply was sold in this market at more than double the official price. Subsidies on fertilizers (and other inputs) may also disproportionately benefit the wealthier farmers and regions (Repetto 1989).

3.20 Despite its potential positive role in soil fertility management and agricultural intensification, heavy fertilizer use can be associated with soil degradation and off-site pollution damages (Barbier and Burgess 1992). Low fertilizer prices, stemming from high levels of subsidy, can encourage such overuse. However, given the relatively low application rates historically, these problems are less likely to be issues in Africa, especially in some Sahelian countries (see Table 3-3), and other aspects of fertilizer use may be more important for NRM. Anderson and Thampapillai (1990) argue that fertilizer use causes an upward shift in the damage function which describes yield as a function of soil depth: as loss of soil quality or quantity occurs, fertilizers can disguise the underlying decline in long-term productivity associated with this loss by maintaining productivity temporarily. Thus, there may be a failure on the part of the farmer to perceive the problem, leading to an inhibited adaptive response and worsening degradation, as a result. Similarly, if fertilizers substitute for soil fertility maintenance alternatives which provide much better soil cover, i.e. mulches and green manures, then fertilizer use may actually encourage soil erosion.

3.21 Substitution effects arising from fertilizer subsidization are at the core of much of the discussion of fertilizer subsidies and NRM, and are certainly more important in Africa than over-

application. Lingard (1992) analyses the theoretical implications of changing factor prices induced by fertilizer subsidies, showing how this leads to a change in production technology which favours artificial fertilizers over natural soil fertility. By reducing its price to the farmer, a subsidy on fertilizer also changes the relative price of fertilizer vis-à-vis alternative technologies for maintaining soil productivity, and thereby reduces the incentive to use these alternative means. In effect, the subsidy causes the short run cost of soil degradation to fall by lowering the costs of replacing lost nutrients with fertilizers (Barbier and Burgess 1992, Bojo 1996).

3.22 Empirical evidence suggests that farmers are indeed very responsive to fertilizer price changes, even though there is no discernible correlation between subsidy level and fertilizer consumption per hectare in Table 3-3. Estimated price elasticities of demand for Asian countries range from -0.44 to -0.85 in the short run, and -0.62 to -2.92 in the longer run (Alicbuson 1987), which is consistent with a suggested range of -1.0 to -2.0, generally (Repetto 1988). A strong response to own price changes is indicative of the presence of important substitutes, and for fertilizers this would seem to be the case. Although empirical evidence for the substitution of inorganic for organic fertilizers is sparse, Repetto (1988) cites several examples where this has been documented, while FAO/IC (1991) provides an example of the reverse effect in Northern Ghana when the national fertilizer subsidy was removed.

3.23 If inorganic fertilizers were perfect substitutes for organic supplies, then price effects and subsidies would be of less concern. However, Repetto (1989) and Mortimore (1989) both list numerous differences between the two, and instead it could be argued that inorganic and organic fertilizers behave more as complements, since organic fertilizers provide a number of extra benefits, as was evident from the Jos Plateau example cited earlier. Mortimore (1989) goes on to note that supplies of organic manures are generally inadequate, in part due to nutrient recycling losses which will always place constraints on the amount of manure available from a mixed cropping system. Thus, there may always be a need for at least some inorganic fertilizer applications, especially on nutrient-poor soils.

3.24 There are additional, interacting factors to consider when examining how subsidies can promote substitution between inorganic and organic fertilizers. As Box 3-2 describes, the substitution effect may also be influenced by various indirect, non-price factors, such as the availability of fuelwood and investments in afforestation (Newcombe 1989). We have already noted that supplies of alternative organic fertilizers may be constrained, so that measures to augment these can be expected to affect NRM decisions. For example, by investing in afforestation there is an indirect effect on soil fertility through the freeing up of dung previously used as fuel. These measures influence NRM by altering the opportunity cost structures, i.e. implicit relative prices, which determine how organic materials are used by the household. Thus, the effect of government fertilizer subsidies for NRM may then depend not only upon the level of the subsidy on fertilizers but also upon competing or complementary interventions in other sub-sectors.

Box 3-2 Complexities in Assessing Fertilizer Subsidies and NRM: The Case of Ethiopia

Assessing the potential role for fertilizer subsidies in Ethiopia requires an understanding of the broader land degradation problem, which has both direct and indirect impacts on soil fertility. For example, the degradation of forested areas has reduced fertility and as trees are removed and fuelwood supplies become strapped, rural dwellers have turned to dung for cooking. This diverts organic fertilizers from maintenance of soil fertility (see Chapter 1). Programmes aimed at enhancing the supply of fuelwood create a farm level incentive to redirect dung to soil fertility restoration and therefore these programmes compete with fertilizer importation. The question then arises as to which route can generate greater net economic benefits, and thereby warrant government efforts to structure incentives accordingly.

The approach outlined above amounts to a *cost-effectiveness analysis* of alternatives for increasing domestic food production. Such an analysis requires estimation of the costs of using imported inorganic fertilizer and comparing these to the cost of displacing one tonne of inorganic fertilizer with an equivalent amount (in terms of nutrients) of dung. In the case of inorganic fertilizer, this calculation is straightforward. Estimates made of the economic cost of importing, distributing and retailing DAP (di-ammonium phosphate) ranged from Br 665 to Br 836/t in 1992, depending upon the location. It should be emphasized that these economic costs do not include the costs of any long-term soil degradation from fertilizer use, as no such estimates were available.

For organic fertilizers a more roundabout approach must be used, one which draws on the dual functions performed by dung within the domestic production system (Newcombe 1989). Since dung is not priced, its value can be derived from its function as a substitute for fuelwood produced from forest plantations, the costs of which are known. Such an approach measures the opportunity costs of giving up dung used as fuel in favour of its use as a fertilizer. Estimating the fertilizer value of dung relied on a number of assumptions and calculations not presented here, but these include the nutrient content of dung vis-à-vis DAP, dung's heating value if used as fuel instead, the comparative heat value of fuelwood and the cost of producing equivalent supplies of fuelwood from plantations. In the end, the opportunity cost savings of being able to use dung as fertilizer rather than as fuel can be expressed as a value in terms of the DAP it could displace. This calculation yielded a dung value of Br 331/t or Br 778/t of DAP, depending on the discount rate used. These latter values can be compared to the costs of imported inorganic fertilizers, which were shown above to range from Br 665/t to Br 836/t of DAP.

Depending on the location and discount rate considered, promoting fuelwood production as an incentive to free dung for use as fertilizer could be a better investment than importing inorganic fertilizer. Adding in the environmental damage costs of fertilizer use, which have not been included, would tend to reinforce this conclusion. Such calculations have implications for the design of appropriate incentives at farm level, including the use of fertilizer subsidies in contrast to the subsidization of other substitute activities; here these would constitute afforestation programmes.

Source: FAO/IC 1992a

Pesticides

3.25 Spraying of pesticides is well known to cause environmental damages, and thus have implications for NRM, particularly when done incorrectly or pesticides are overused (Mason 1996, Pretty 1995, Pearce and Warford 1993, Repetto 1988, Beeby 1993). If an agroecological perspective is adopted, then pesticide application can be viewed as a shock to the agroecosystem, which disrupts useful ecological functions such as the pest control services provided by natural enemies.[1] Off-farm effects constitute a classic market failure and even on-farm damages can be partly attributed to a lack of farmer knowledge about the potential for damages, which represents a form of market or information failure. The presence of these market failures encourages overuse of pesticides and subsidies serve to exacerbate the problem. Nonetheless, there remains a place for pesticides as part of a broader pest control strategy which incorporates other control strategies and

[1] The key NRM effects arising from pesticide use include increasing pest resistance, the destruction of non-target and natural enemy species, the appearance of new pests to replace those eliminated by pesticides and harmful effects on soil processes, especially loss of soil micro-organisms (Repetto 1985; IPM Task Force, no date). For example, Repetto notes that by 1980 more than 400 insect species were known to have developed resistance to pesticides.

balances the risks of crop losses against the costs of pest control (Pretty 1995, Beeby 1993, Repetto 1989). Increasingly better-targeted pesticides with fewer collateral effects are a step in the right direction (Pretty 1995). By increasing production from existing lands, pesticides can also be argued to reduce the need to bring marginal lands into production.

3.26 Pesticides are not used as extensively in Africa as in Asia, where the Green Revolution has led to the perception that large quantities of pesticides are required to protect yields from the new, more vulnerable crop varieties. Pesticides are primarily used on cash crops; for example, 51% of all pesticides used in Senegal go to protecting cotton (Repetto 1988). One of the tenets of agricultural development under the Green Revolution and related paradigms has been the subsidization of agro-chemicals to encourage their use. As a result, pesticides have been highly subsidized in a number of developing countries, at a substantial expense to national treasuries. Table 3-4 shows the average rate and value for pesticide subsidies in a sample of nine developing countries during the mid-1980s. Various channels have been used to subsidize pesticide use, including tax/tariff concessions, low interest farm credits, local manufacturing incentives and free distribution under agricultural support programmes (Repetto 1985).

Table 3-4 Estimated Average Rate and Value of Pesticide Subsidies

Country	Percentage of Full Retail Costs	Total Value (millions of US$)	Value per Capita (US$)
China	19	285	0.3
Columbia	44	69	2.5
Ecuador	41	14	1.7
Egypt	83	207	4.7
Ghana	67	20	1.7
Honduras	29	12	3.0
Indonesia	82	128	0.8
Senegal	89	4	0.7

Source: Repetto (1989)

3.27 By reducing the effective price paid for pesticides, government subsidies encourage their use. Many of the processes involved operate identically to the effects described above concerning fertilizers and NRM, so only a few salient points are addressed here. For example, there may be an aggregate effect, as the decline in pest control costs leads farmers to do more of it. Overuse of pesticides has been documented in a number of countries where subsidies have been prevalent and can arise via several behavioural responses from farmers (Teng 1994). With pesticides priced cheaply, farmers often follow a 'pre-emptive strike' approach to pest management, spraying according to the calendar, i.e. scheduled spraying, rather than at times of infestation only (Barbier and Conway 1990). Thus, there is a high probability that more pesticides will be used than really necessary. Even if *economic thresholds* are used to determine when to spray, the subsidy on pesticides lowers these thresholds and encourages earlier and more frequent spraying (Repetto 1985).

3.28 Substitution effects may also play an important role in determining the effects of pesticide subsidies on NRM. There are a number of options available to farmers for the management of pest problems, two of the key options being IPM and pest resistant varieties. As with comparisons of inorganic and organic fertilizers, these incur few if any of the environmental damages cited for pesticide use.[1] Pesticide subsidies change the relative costs of pest management alternatives and,

[1] IPM is premised on the notion that a farmer's field has the qualities of an ecosystem or agroecosystem, more specifically, and that good pest management is simply the appropriate management of this ecosystem. To practice IPM requires a

therefore, can have a bearing on producers' choices of control strategies. Subsidies cause the cost of pesticide spraying to fall in comparison to more sustainable pest control strategies, and these then become relatively less attractive. Box 3-3 provides an example from Indonesia of the type of cost comparison envisioned. By encouraging less use of IPM and other sustainable control options, pesticide subsidies can have significant implications for NRM. However, this need not be the case under all circumstances. For example, Norgaard (1988) describes how the introduction of the parasitic wasp *Epidinocarsis lopezi* into the cassava-growing region of Africa significantly reduced the threat of the cassava mealy bug, generating a cost-benefit ratio of 149 to 1 for this IPM programme. Subsidies on pesticides in these areas would have had little bearing on the effectiveness of this programme.

Box 3-3 Comparing the Costs of Pesticide Spraying and IPM: An Example from Indonesia

Subsidies on pesticides can affect their relative profitability vis-à-vis alternative pest control alternatives such as IPM, thereby altering farmer incentives. A study concerned with extending Indonesia's successful IPM programme in rice to estate crops looked at how the costs of spraying pesticides compared to using IPM, in this case focusing on the use of the biological control agent (BCA) *Beauveria* to control coffee berry borer. *Beauveria* is applied directly to infected areas as a suspension, using a small handheld or cylinder hand sprayer. Costs for applying *Beauveria* to coffee were estimated on the basis of assumptions concerning application rates, water and sugar requirements for dilution, application labour and spraying equipment costs. The estimated annual cost of applying *Beauveria* was found to be Rp 55,050 per ha (US$1.00 = Rs 2140).

The main uncertainty in determining pesticide spraying costs was determining the number of sprays which would provide approximately equivalent protection to that of the recommended dose of *Beauveria* costed above. The number is likely to fall between 4 and 8 sprays, each one requiring about one litre of insecticide. To reflect this uncertainty, costs for both dose levels were calculated. On the basis of a number of assumptions, spraying with pesticides would cost from Rp 135,000 per ha, for four applications annually, to Rp 267,000, for 8 applications. These spraying costs exclude any consideration of health damages, which would obviously reduce pesticide benefits from the farmer's perspective, and might result in a comparison unduly favouring spraying as a pest control alternative. As a consequence, an adjustment was made to the original spraying cost figures using a benefits transfer approach, which takes a value estimated for an alternative site and uses this to estimate a value for the site in question. Research by Pingali *et al* (1994) in the Philippines suggests the incremental health cost to the sprayer would amount to about Rp 190,000 per ha for four sprays annually, and Rp 304,000 per ha for eight sprays. Adding these social costs to the application costs estimated above results in much higher total costs, ranging from 325,000 Rp per ha to 571,000 Rp per ha, depending on the rate of application.

A simple cost comparison suggests that BCA use is significantly less expensive than pesticide use, especially when health impacts are considered. As a result, only very large subsidies on pesticides would tip the balance in favour of using pesticides instead of IPM on a cost basis. At the time, there was no official subsidy on pesticides but large quantities were being distributed freely under promotional schemes. At an effective 100% subsidy, these actions presumably would reduce the attractiveness of using IPM, with follow-on consequences for NRM.

Source: FAO/IC 1995

Irrigation Water Supply

3.29 In many parts of dryland Africa, it is not soil fertility and pest damages that limit productivity but soil moisture. One of the means by which governments have attempted to

menu or buffet of possible actions which can be called upon to address specific pest problems as they arise, including the limited application of pesticides, sanitation techniques, cropping strategies and choice of cultivars. Such an approach has been highly successful for reducing pesticide use in rice farming in Southeast Asia, particularly in Indonesia (Teng 1994, Useem *et al* 1992). Kiss and Merman (1991) cite examples of successful IPM programmes in Togo (cotton) and Burkina Faso (rice), where pesticide use has been halved but with no yield loss.

overcome these constraints, aside from water harvesting techniques on drylands, has been investments in irrigation projects. Once again, we find that such strategies have played a role in expanding agricultural production to meet rising food demands and to promote land settlement and regional development (Anderson and Thampapillai 1990). Estimates cited by Binswanger (1989) indicate that for a large sample of countries, a one- percent increase in the proportion of land irrigated is associated with a 1.62 percent increase in agricultural output. As one of several factors influencing rice yields in Asia, irrigation has been shown to account for about 29% of incremental rice production over the period 1965 to 1980 (Barker *et al* 1985). Nonetheless, overuse of irrigation water is associated with numerous environmental damages, many of which impinge on NRM, and pricing and subsidy issues are an important dimension of the problem.

3.30 Subsidies in irrigation water pricing are pervasive (Sampath 1992, Anderson and Thampapillai 1990, Barbier and Burgess 1992, Postel 1990). Adams (1992) notes that "the northern Nigerian schemes actually require continuous government subsidy simply to meet annual running costs (p. 176)". In a global study of World Bank financed irrigation projects, it was found that only 30% of project costs were recovered, the shortfall representing an implicit subsidy. Moreover, the water charges collected represented only 17% of incremental farm income (Duane 1975). Table 3-5 shows that cost recovery rates for a selection of Asian countries in the early 1980s varied widely, but that if total capital and operating costs are considered, the amount recovered exceeded 20% in only one country. Postel (1990) notes that water prices in most developing countries result in only 10 to 20% cost recovery rates.

Table 3-5 Cost Recovery in Irrigation in Selected Asian Countries

Country	Ratio of Actual Revenues to O&M Costs	Ratio of Actual Revenues to Capital Plus O&M Costs*
Bangladesh	18	1
Indonesia	78	14
Korea, Republic of	91	18
Nepal	57	7
Philippines	120	22
Thailand	28	6

Source: Repetto (1988)
(*) capital costs are moderate estimates only

3.31 Numerous environmental problems have been recognized as stemming from the siting, construction and management of 'modern' irrigation projects, including damages associated with the headworks, distribution systems and on-farm water use (Cleaver and Schreiber 1994, Repetto 1986, Postel 1990). Traditional irrigation techniques, such as flood recession, do not typically contribute to land degradation but may create resource use conflicts in some regions, such as has occurred at the Inland Delta of the Niger in Mali (Moorehead 1989, Postel 1990). Pricing and subsidy issues are primarily linked to environmental problems via their relationship with on-farm water use and the opportunity costs of irrigation water. For the former impacts, excessive irrigation and poor water use efficiencies are the main causes of damages.

3.32 In addition to on-farm damages from overwatering, there may be off-farm effects as well. In most cases, water diverted for irrigation has an opportunity cost, especially in water-scarce regions like the Sudano-Sahelian zone of West Africa (Cleaver and Schreiber 1994). Water that is wastefully diverted for irrigation purposes because of its low price, is not available for other useful purposes, and often these alternatives involve NRM issues. Box 3-4 describes the case of the Hadejia-Nguru wetlands in Northeast Nigeria, which support a multitude of economic

activities, either directly or indirectly. Water prices charged under regional irrigation schemes not only fail to cover project development and operating costs (see above), but exclude consideration of the opportunity costs of the water and the resulting external costs of diverting water away from the wetlands. In such cases, subsidizing input use actually worsens a market failure rather than correcting for it, and thus constitutes a type of policy failure, as noted in Chapter 2.

Box 3-4 Opportunity Costs Associated with Irrigation Water Diversions in Northern Nigeria

In Northeast Nigeria, a region where water is the limiting resource for development, an extensive floodplain is drained by the Komadugu Yobe river which then flows onwards to Lake Chad. Although referred to as the Hadejia-Nguru wetlands, after the two principal towns in the area, much of the floodplain is dry for some or all of the year. In recent decades the Hadejia-Nguru wetlands have come under increasing pressure from drought and water resource schemes. Upstream developments are affecting flows into the wetlands, since dams reduce the size of flood flows by diverting water for irrigation. Downstream agriculture has also benefited from the construction of bypass channels which divert water past the wetlands.

These developments are taking place without consideration of their impacts on the Hadejia-Nguru wetlands or any subsequent loss of economic benefits that are currently provided by use of the floodplain. Water diverted to upstream and downstream uses clearly has an 'opportunity cost', in the form of the various wetland benefits provided by the floodplain. The Hadejia-Nguru wetlands provide essential income and nutrition benefits in the form of agriculture, grazing resources, non-timber forest products, fuelwood and fishing for local populations. The wetlands also serve wider regional economic purposes, such as providing dry-season grazing for semi-nomadic pastoralists, agricultural surpluses for neighbouring states, groundwater recharge of the Chad Formation aquifer and 'insurance' resources in times of drought.

A valuation study was conducted to assess some of the key direct use values which the floodplain provides to local populations and thus the opportunity cost to Nigeria of diverting inflowing waters for irrigation use. The economic analysis indicates that these benefits are substantial on both a per hectare basis and a water input basis, i.e. the minimum and maximum amount of floodwater required to sustain them. This proves to be the case even when the agricultural benefits were adjusted to take into account the unsustainability of much pump-irrigated wheat production within the wetlands. The present value of the aggregate stream of agricultural, fishing and fuelwood benefits were estimated to be around N850 to N1280 per hectare (7.5 Naira = US$ 1), or around N240 to N370 per 103m3 (based on the maximum flood inputs). Continual loss of groundwater storage and recharge will also have a significant impact on the numerous small villages throughout the region that depend on the aquifer for domestic use and agricultural activities. Although valuation of these impacts is difficult, a separate analysis is attempting to value these (Acharya and Barbier 1997). In sum, the economic importance of the Hadejia-Nguru wetlands suggests that the benefits they provide cannot be excluded as an opportunity cost of any scheme that diverts water away from the floodplain system.

Source: Barbier, Acreman and Knowler 1997

3.33 From an incentives perspective, low prices for irrigation water are therefore likely to encourage its inefficient use, and lead to overwatering and the types of onfarm and collateral damages described above (Anderson and Thampapillai 1990). However, the economic aspects of pricing in the irrigation sector are complex, as a result of the nature of water as a resource commodity and the conditions under which it is conveyed to users. Under the irrigation system conditions of many developing countries, water conveyed through irrigation systems has the characteristics of a fugitive or *de facto* open access resource, which differentiates it from the other purchased inputs we have considered. These qualities are partly the result of inefficient pricing mechanisms, such as unit area pricing (in contrast to volumetric pricing), which can further encourage overuse regardless of the actual level of prices. In the case of groundwater irrigation, the sustainability of withdrawal rates may be linked to price levels: prices should be sufficiently high to reflect the user costs of withdrawals - that is, the future losses in net benefits from exploitation today. If prices are too low instead, more rapid depletion of aquifers is stimulated,

with consequences for NRM now and in the future (Postel 1990). Sampath (1992) and Tsur and Dinar (1995) discuss the issues pertinent to efficient economic pricing in the irrigation sector.

3.34 Ultimately, pricing in irrigation is associated with overall system management and thence onwards to NRM. For example, when prices do not meet operating and capital depreciation costs, there is a greater likelihood of deterioration in a system's water use efficiency. This situation further leads to low producer returns and a declining ability to contribute to meeting system costs. Thus, a vicious circle of spiralling environmental degradation results, as worsening water use efficiencies create more and more damage (Postel 1990). Subsidized water prices create problems of excess demand which must be dealt with through water rationing and other inefficient allocation mechanisms, which result in the poor use of land resources (Repetto 1988). Moreover, Repetto (1988) emphasizes the rent-seeking behaviour which arises in response to subsidized irrigation water prices and/or inefficient charging mechanisms. Since farmers and middlemen do not pay the full costs of system expansion, they have an incentive to seek additional water supplies, the value of which may become capitalized into land values (Pearce and Warford 1993). Rather than serving to ensure the efficient allocation of society's resources, irrigation subsidies promote overuse of water and inappropriate system expansion, with all the consequences for NRM we have cited above.

Mechanization and Draft Animal Power

3.35 An increasing degree of mechanization is usually seen as one possible indicator of farming system intensification, and this is borne out by comparisons of African and Asian agriculture (Boserup 1965). However, the promotion of mechanized farming in Africa is seen to be at odds with contemporary views of sustainable agriculture (see Chapter 1), perhaps more than for any other purchased input (Pretty 1995, Repetto 1988).[1] Mechanized agriculture can be an agent of land degradation when practiced on a large scale using heavy tractors and where operators are not well trained (see Box 3-5). Discussions of mechanization must also consider the use of draft animal power, which similarly has positive and negative implications for NRM, although it is typically viewed as having fewer environmental consequences than mechanized farming. A detailed account of the role of draft power and mechanization in the development of Africa's agricultural sector is provided by Pingali *et al* (1987).

3.36 Tractor use in Africa is well below that of Asia (FAO 1993). West African circumstances vary, with some of the coastal countries having relatively greater numbers of tractors than the Sahelian countries. Despite being less common, tractor use has been subsidized in many African countries, via favourable import treatment, generous depreciation allowances and other tax benefits, and generally as part of major "tractorization" programmes, subsequently doomed to failure (Starkey 1991, Repetto 1988, Pingali 1987). Even where foreign exchange is limited, governments sometimes make special provisions for the import of agricultural machinery. In Nigeria, the first National Rolling Plan committed Naira 235 million (US$1: 8.0 Naira) to the purchase of tractors and farm machinery (FAO/IC 1990). Box 3-5 describes the recent situation in Ghana for tractor services and suggests that a hefty indirect subsidy is in place, although direct subsidies have been removed. This situation likely applies to other countries as well, although there are few data available on the extent of mechanization subsidies in other countries in West

[1] The principle problems relate to soil compaction and erosion; these lead to reduced porosity and less water infiltration, which creates more runoff and, consequently, erosion (Repetto 1988). Sometimes field levelling is practised and this can damage thin topsoils. Environmental problems may also be associated with the clearing of large areas of their sheltering trees, which may be necessary to allow unimpeded movement of equipment.

Africa. Such assistance provided to mechanization can be economically inefficient, promoting the overuse of tractors and resulting in the environmental damages detailed above (Southgate 1988).

Box 3-5 Agricultural Mechanization and Subsidies in Ghana

Mechanized farming was until recently a central part of Government agricultural policy, with tractor sales subject to large subsidies. Even proper use of tractors has been responsible for land degradation in Ghana because of the deep furrowing and tree clearing involved; improper use increases the degradation significantly. In addition, large mechanized farming schemes have alienated land and displaced smallholder labour with capital. Even though direct investment subsidies have been removed, the residual effects of the earlier subsidies, and other indirect subsidies, continue to exist. For example, large mechanized farmers receive a 5-year tax holiday, which constitutes an indirect subsidy. Tractor operators are also offered a limited amount of free training by the Ministry of Agriculture, which may constitute a subsidy but may also serve to reduce degradation.

Most of the 4,000 tractors now in use in Ghana were purchased during the period when subsidies were in force, so that even now prices charged for tractor services remain below their true cost. This is exacerbated by the poor state of repair of most tractors. Tractor charges are unlikely to have included adequate compensation for upkeep, so that tractor operators have effectively provided a further subsidy to mechanized farming. The current full cost recovery prices charged by tractor operators using the existing tractor stock was about 20,000 cedis/ha in 1991 (US$1: 365 cedis), while use of newly purchased equipment raised the cost to about 48,000 cedis/ha. The difference provides a measure of the implicit subsidy on tractor services in place at the time. At the higher price, the use of tractors is unlikely to be economically viable. Eventually the existing stock of tractors will become inoperable and market forces will govern the use of tractors; thus, no policy prescription concerning tractors and improved land management may be necessary.

Source: FAO/IC 1991

3.37 Environmental damage is also associated with the mechanized clearing of new lands for agriculture, often under broader settlement schemes in frontier areas (Southgate 1988). Repetto (1988) argues that subsidies on mechanized clearing not only encourage more of it, but alter the way in which it is done, resulting in much greater harm to forest areas. It is likely that the equipment used in these cases was highly subsidized (see above). Often, subsidized machinery is one component in a general policy to promote extensification into fragile frontier areas which may include additional incentives, such as legal stipulations or tax write-offs for clearing land within given periods, even if there is no intent to farm it (Pearce and Warford 1993). If the predominant soils are clayey, mechanization is required for cultivation, whereas in its absence the land may be used for grazing, with less potential for erosion (Pingali *et al* 1987). In Nigeria, the 1978 Land Use Act allowed many wealthy and influential individuals to obtain occupancy certificates to new lands which were subsequently cleared using heavy equipment in order to prevent smallholders from gaining access to these lands (Cleaver and Schreiber 1994).

3.38 Draft power has also contributed to agricultural output in West Africa, with some 60,000 or so African farmers having adopted it (Starkey 1991). In environmental terms draft animal power is more benign than the use of tractors, since most of the potential damages associated with mechanization are either much reduced or absent. Even where environmental problems are found in association with draft power tillage systems, these are usually not caused by the use of animals directly (Starkey 1991). Moreover, the proper management of draft animals results in significant inputs of manure to the cropping system, which displaces demand for inorganic fertilizers to some extent.

3.39 However, draft power can entail some difficulties for NRM as well, especially where it permits or is associated with an expansion of the cropped area, i.e. extensification. Pingali *et al* (1987) indicate that in Africa these additional areas are often planted with sole cash crops such as

cotton, groundnuts and rice; in general, these crops can involve more substantial erosion risk than mixed food crop stands (see Table 3-2). Draft animals must also be fed, which may add to overgrazing or else land must be set aside to grow fodder crops. In his study of Botswana, Perrings (1996) argues that subsidies on draft power investments in that country have increased the benefits of holding cattle and reduced offtake rates, with consequences for grazing pressure on rangelands.

3.40 Whether tractors will be overused depends upon the incentive structure farmers face in choosing between manual cultivation, draft animal power and tractors. While other purchased inputs primarily substitute for land, mechanization more commonly substitutes for labour and draft power, and its adoption is highly influenced by the relative costs and market conditions governing these substitutes (Ellis 1993, Jaeger and Matlon 1990, Pingali 1987). Since mechanization competes with draught power in some regions of Africa, subsidies can tip the balance in its favour and discourage the use of draft animals.

3.41 Profitability is not the only consideration that goes into deciding on a technique for land clearing and tillage. In a review of economic and ecological factors inhibiting the adoption of draft power in Sub-Saharan Africa, Ehui and Polson (1993) argue that areas with light soils or subject to erosion are less amenable to the adoption of draft power in place of manual technology. Pingali (1987) points out several additional constraints which may uniquely inhibit the adoption of draft power, including a lack of "veterinary services and training programmes for farmers, animals and blacksmiths." (p. 19) Where policies can address these constraints, in addition to the obvious need to reduce mechanization subsidies, the incentive structure can be altered in favour of draft power over machinery, with generally positive consequences for NRM.

3.42 There may be further labour demand and supply implications of the adoption of mechanized farming, with additional consequences for NRM. Southgate (1988) and Ellis (1993) argue that tractor subsidies release labour, which can result in added land pressure in sensitive areas (also see Box 3-5). However, such views must take account of the changing input factor conditions which may lead to mechanization in the first place. Normally, this occurs as labour becomes scarce or serves as the limiting input at peak periods in the cropping season. If labour markets function reasonably well, then labour's price will rise, inducing the technical change represented by the adoption of labour-saving technologies such as draft or tractor power. Decisions about the adoption of draft power must take into account further labour demands, such as the need to feed and water oxen over the dry season (Ehui and Polson 1993). Toulmin (1991) points out that in Mali this means at least one male must remain behind and forsake the returns from seasonal migration for work purposes, which could fetch up to MF 25,000 in the early 1980s. This reduction in off-farm income can affect the household's use of its natural resource base, as was discussed in Chapter 2.

Labour Supply

3.43 Labour is an important farm input from an NRM standpoint, not just because it contributes to crop production, but also because of its role in improved land management practices, i.e. as a direct input to soil and water conservation technologies. Modern views of land management integrate crop production and soil and water conservation and so blur the distinction between these in terms of labour use (Shaxson *et al* 1989). In a more indirect sense, labour markets have an important function in the wider process of agricultural development, and therefore influence the path this development takes, with consequences for sustainability and overall NRM within the

agricultural sector. Box 3-6 explores some of these more theoretical issues within the context of agricultural development.

Box 3-6 Some Theoretical Aspects of Labour Use in Agricultural Development and NRM

In neoclassical economic theory, labour should be employed up to the point at which the last unit of labour produces output just equal to the wage it is paid. Complicating this picture in developing countries is the pull factor associated with urban wages and employment opportunities, or land availability in frontier areas, as discussed earlier in Chapter 2. Indeed, earlier theories of labour mobility assumed that rural labour was of sufficiently low productivity that its loss to the urban areas would have little impact on agricultural production (Lensink 1996). In a perfectly functioning labour market, these processes would interact to ensure efficient labour use in rural areas. If in addition natural resources are priced at their true social value, i.e. there are no market or policy failures, then the concerns about a poverty-population-environmental degradation nexus would probably not exist (Cleaver and Schreiber 1994). We have already argued that distortions in natural resource and agricultural prices contribute to poor NRM; the same is likely to be true of labour markets. Many problems can distort the rural-urban labour market, such as a lack of information about where alternative urban employment opportunities may exist. As a result, Shuh and Archibald (1996) argue a 'damming up' of rural labour supplies may occur, forcing an expansion of low opportunity cost labour on to marginal lands where the net returns from cultivation are equally low and sustainability is questionable.

On a more positive note, rising labour-intensity in agricultural production can be an alternative source of intensification to mechanization, in response to population growth (Boserup 1965). However, this presents problems for rural societies since such intensification usually comes at the expense of diminishing marginal productivity of labour and, by extension, lower wages and greater poverty (Barbier 1995 - ODA). We have already made the point that lower incomes can result in a poverty-degradation trap (see Chapter 2). Instead, if labour is allowed to drain away to employment opportunities elsewhere, and its marginal productivity locally is permitted to rise, then rural wage rates can keep pace with rising urban wages, avoiding the poverty-degradation trap (Shuh and Archibald 1996). This process is apparent in positive elasticity responses of labour-saving tractor and draft power usage to urban wage changes, but this can have uncertain implications for NRM, as outlined in the previous section (Binswanger 1989). Eventually, a 'factor-intensity reversal' may occur, if the real labour wage rises more quickly than the returns to capital and land, with implications for the choice of production technology, and consequently for NRM (Thompson 1996). This discussion reveals the difficulty of generalizing about interactions between labour and intensification at the aggregate level.

3.44 Where land is scarce farmers would be expected to optimize output per unit of land, whereas if labour is in limited supply, as has traditionally been the case for Africa until more recently, output would be maximized per unit of this input (Stocking and Abel 1992, Thompson 1996). In the latter situation, the opportunity cost of incremental labour is liable to be high. These conditions have important repercussions for assessing the net returns from cultivating erosive versus non-erosive crops and from investing in land management improvements. For example, cash crops tend to involve much greater labour inputs per unit of land than food crops, requiring very high profit margins in order to justify their extensive cultivation if labour is in short supply (Barbier and Burgess 1992b). Similarly, but with quite the opposite effect on NRM in the Sudano-Sahelian zone, many land management improvements involve substantial inputs of labour relative to other inputs.

3.45 Table 3-6 shows the labour requirements for a selection of structural and vegetative or biological techniques for soil and water conservation. Values range from several hundred to more than one thousand man-days for the construction of structural soil conservation works, which constitutes one of the many arguments against this latter approach to land management (Shaxson *et al* 1989). IPM can also involve incremental labour in comparison to pesticide use: in Indonesia, for example, increasing urban employment opportunities and wages may be working against the adoption of IPM in the estate crop sector (see Box 3-3). Vegetative and biological approaches to improve land management often require much lower amounts of labour to establish and even to

maintain on an annual basis, as shown in Table 3-6 and by recent studies of land management in West Africa conducted by the FAO Investment Centre and described in Box 2-5.[1] Incremental labour inputs calculated in the latter studies can actually be negative for some technologies in certain agroecological settings (Knowler, 1994). This occurs because greater productivity may be possible from the smaller productive area remaining after structures or vegetative strips are taken into account, and some labour tasks become less demanding (see below). The labour savings these advantages provide dominate other aspects, such as increased labour for the harvesting of conservation-augmented yields.

[1] Some of the results of these studies are also presented and discussed in Cleaver and Schreiber (1994); see especially Table A-28.

Table 3-6 Indicative Labour Requirements for Soil Conservation Technologies

Country	Conservation Technology	Labour Input (man-days/ha/yr)	Source
Kenya	-fanya juu terrace, 5% - 35% slope	136 - 281	Wenner 1980
Kenya (Embu-Meru)	-fanya juu terrace, 5% slope	150	Barrett 1985
El Salvador (Acelhuate R. Basin)	-Hillside ditches with vegetation-protected main drains, 20% - 40% slope	84 - 143	Wall 1981
	-Rock wall barriers with drains, 20% - 40% slope	253 - 310	
	-Bench-terracing with masonry-protected main drains, 20% - 40% slope	238 - 283	
	-Live barriers, 20% - 40% slope	40 - 43	
Honduras	Biological conservation at intermediate technology (additional labour vs maize monocrop),		Rodriguez 1980
	-maize/cassava/beans intercrop	148	
	-maize/cassava including terrace	207	
Jamaica	Bench terraces, 13% slope		Sheng 1986a
	-construction	496	
	-annual maintenance	42	
Thailand	Bench terraces, 4m wide	500	Sheng 1986b
	Hillside ditches, <40% slopes	100	
	Orchard terraces, 1.75m wide	112	
	Individual hand-dug basins, 200/ha	12	
	Contour dykes to form natural terraces	100	
	Grassed waterway, <20% slopes	18	
Peru	Terraces with grass-planted side slopes,		Alfaro-Moreno 1988
	-terraces	336	
	-contour furrows	110	
	-infiltration ditch	205	
	Terraces with stone side slopes,		
	-terraces	1181	
	-contour furrows	328	
	-infiltration ditch	57	
India (N.E.)	Establishment of terrace cultivation	696	Mishra *et al* 1981
Indonesia (Java)	Bench terraces, <50% slopes	750 - 1800	Barbier 1988
Vietnam	Agroforestry and soil conservation system,		Field notes
	-establishment, including tree planting	1500	
	-annual maintenance	55	

Source: Stocking and Abel 1992

3.46 Where a high opportunity cost of labour prevails, the net returns to incremental labour gives a good indication of a technology's attractiveness. Various analyses of soil and water

conservation economics have considered the returns to labour. In the FAO/IC West African studies cited above, values per incremental man-day range from negatives to nearly US$20 (1990/91 prices), depending on the mix of technology and location (Knowler 1994). In their study of agroforestry technologies in Central America and the Caribbean, Current and Scherr (1995) find returns to labour varying even more widely, from zero to US$55 per day (1992 prices). Only where these returns exceed the opportunity cost of the necessary labour, likely to be in the neighbourhood of several dollars per day, is investing scarce labour in these activities sensible. Again, little can be concluded from such analyses about the overall viability of improved land management, since the figures range so widely, except to say the opportunity cost of labour obviously plays a critical role in determining incentives to adopt improved NRM.

3.47 Clearly, if labour has a high opportunity cost within the household, labour-intensive improvements to land management will become more difficult to undertake. What constitutes this opportunity cost in financial terms will depend upon whether leisure (non-production), productive on-farm activities or off-farm work are curtailed in order to undertake land management measures, or whether labour is hired to undertake any works, according to Stocking and Abel (1992). They consider the constraining influence labour's availability and value can have on land management, and discuss what factors can lead to variations in its opportunity cost. For example, social differentiation within households on the basis of gender can be at fault, as we have already pointed out, as can discrepancies in wealth status between households. Ellis (1993) points out how labour constraints may develop in response to various labour market imperfections, resulting in high opportunity costs attributable to this input and consequently less interest in conservation works.

3.48 Furthermore, the seasonal nature of cropping results in peak labour demand periods, which can conflict with the labour requirements for conservation technologies, reducing adoption rates for the latter (Cleaver and Schreiber 1994, Stocking and Abel 1992). African farming is well-known to involve such peaks in demand, and these can have a major impact on household cropping decisions, limiting the area cropped or influencing the types of crops planted. In his study of smallholder labour use in Africa, Cleave (1974) lists a number of labour profile studies which indicate that these peaks can vary from one tribal group location to another, and that outside of these peaks there are substantial lulls in demand for agricultural labour. Of the dozen or so West African locations considered, seasonal peaks were spread over seven of twelve months, and only 38% to 75% of the available labour (based on peak demand on a twelve month basis) were utilized for cropping activities.

3.49 These peaks may occur just when labour is required for soil and water conservation, such as with *tied ridging*, which is performed annually as part of land preparation and sowing, and *contour furrows/terraces*, which often require maintenance labour after heavy rains, when weeding is also needed (Stocking and Abel 1992). Attah-Krah and Francis (1987) have shown that one of the key reasons for the poor adoption of *alley cropping*, despite its supposed yield and soil fertility benefits, has been the need to prune hedgerows at the same time weeding requirements are at a peak.

3.50 Where conservation technologies work in reverse, and save labour at critical periods, their attractiveness can be enhanced. For example, *fodder banks*, a livestock-soil management system developed by the International Livestock Center for Africa (ILCA) which introduces leguminous grasses into the crop rotation to provide forage and soil fertility benefits, reduces ridging labour because of the better soil conditions created. Despite increasing overall cropping labour by about 17%, the technology reduces it during one of the most critical periods (Tarawali *et al* 1987). On

the basis of this example, labour-intensive conservation techniques such as *stone wall terraces, bunds* and *drainage structures,* which draw on labour during the dry season when agricultural demand for labour is lower, might appear particularly attractive.

3.51 Stocking and Abel (1992) warn against such a general conclusion, noting that off-season time may be constrained for reasons other than cropping demand. We have already seen that in Mali, retaining labour on-farm to tend oxen has a high opportunity cost (see above). Ellis (1993) reports data on hours spent at various household activities by men and women in a number of countries, including household work, income-earning and crop production. The implication is that high proportions of household labour go to domestic chores and income-earning, in some cases as much as 75%. Thus, in the overall allocation of household time, agricultural activities may not predominate, and the apparent availability of low opportunity cost labour for the construction of conservation structures may be illusory.

4. VARIABLE INCENTIVES AT THE MACROECONOMIC LEVEL

4.1 In this chapter, we examine the indirect incentives effects for NRM associated with national economic policies, such as fiscal and monetary measures and trade and tariff policies. These policies may be enacted either in isolation or as part of far-reaching structural adjustment programmes (SAPs). Household behaviour also may alter as a result of exogenous international developments, and when these arise as sudden sharp changes they represent 'shocks' to the agroecological system, inducing changes in NRM. Macroeconomic policies or external shocks may create incentives to conserve or degrade natural resources in the same way that domestic policies do, as when international agricultural prices adjust and this is felt at the farmgate.

4.2 Changes in indirect incentives emanating from outside the agricultural sector may also affect agricultural production in quite subtle ways, as when sharp expansions or contractions in sectors which compete for labour with agriculture lead to changing labour market conditions in the agricultural sector. Similarly, the linkage between trade and NRM has its most immediate impact on the production and marketing of exported crops and livestock products, but its influence extends beyond this to the more broadly understood category of 'tradable' commodities. Changes in the production and management of tradables can have far-reaching effects on land use and NRM. Moreover, variable incentives arising from the macro level environment will influence NRM in a more roundabout way because of the pervasive effects of economy-wide policies; targeting broad macroeconomic variables like inflation, employment or the balance of payments. As the evidence presented in this chapter demonstrates, developments outside of the agricultural sector can be an important source of changing conditions at the farm level, but one which would be missed if a review concentrated solely on the agriculture sector.

4.3 Many research studies do not consider the complex feedback effects referred to above, which arise when large macro level adjustments lead to adjustments in other sectors, with the process continuing until these 'general equilibrium effects' are fully played out. To analyze how such complex processes affect NRM incentives at the farm level requires sophisticated models which link up the various sectors of the economy and incorporate adjustment processes and feedback mechanisms. This approach contrasts with the more familiar 'partial' type analysis usually employed when assessing the impacts of agricultural sector policies in isolation. One of the more successful modelling techniques used to capture the more pervasive, economy-wide effects of policies is general equilibrium analysis, which in practical terms requires the development of computable general equilibrium models (CGE models). Several examples of the use of CGE models to analyze the impact of macroeconomic policies and external shocks on NRM are discussed in the following sections.

A. MACROECONOMIC POLICIES AND NRM

Early this decade, it was acknowledged that macroeconomic policies may be indirectly encouraging or discouraging resource degradation in developing countries, stimulating organizations such as the World Bank to investigate these hitherto poorly understood environment-development linkages (El-Serafy 1993). An ambitious programme at the Bank was initiated into the nature of economy-wide policy effects on the environment, culminating in a series of case studies and reports, the latter serving as a basis for parts of the discussion below (Munasinghe 1996, Munasinghe and Cruz 1995). An extensive review of the many case studies

conducted under this research programme is not attempted, although lessons learned are incorporated. For extensive reviews of the case study literature, the reports cited above are recommended. In addition to the World Bank, even a reluctant IMF was stirred into action, undertaking its own investigations into the field via a series of discussion papers and a book (Gandhi 1996). Contrasting these multilaterally-linked and generally more benign views of the potential impacts of international and domestic policy-making on the environment are highly critical works by authors such as Harrison (1987), George (1993) and Adams (1991). Much of the independent academic literature falls in between these more polarized positions.

Macroeconomic Policy (Domestic Sector) Linkages to NRM

4.4 Economy-wide policymaking in Africa, especially West Africa, has been characterized historically by a highly interventionist approach. As a result, government consumption accounts for a sizeable share of economic activity, averaging from about 10 to 35% of GDP in West African countries in 1990, compared to an average for all low income countries of 11% (World Bank 1992). Agriculture typically constitutes a substantial share of economic activity in most developing regions; in 1992 the sectoral share of GDP for all Africa was 20% versus shares in East Asia of 21% and South Asia at 32%. However, for key West African countries the significance is much greater: in Nigeria and Côte d'Ivoire agriculture accounts for 37% of GDP, while in Ghana the figure is higher still, at 49%. Yet the macroeconomic policy stance has traditionally favoured manufacturing and import substitution at the expense of the agricultural sector.

4.5 Cleaver (1985) describes the effects of this traditional macroeconomic policy stance. In addition to trade biases, artificially low retail prices for certain food staples encourage their consumption in urban areas over more traditional, unsubsidized staples. Included in the former group are wheat, rice and maize flour, which become preferred over cassava, millet and sorghum. Furthermore, expansive fiscal and monetary policies have characterized many African countries with consequences for inflation, interest rates and exchange rates (Lensink 1996). One NRM consequence is that high inflation can stimulate investors to invest in land, as a hedge against the declining value of assets in other forms (Shuh and Archibald 1996). In Latin America, this effect has caused widespread extensification and land conversion (as opposed to intensification). In this section, we will concentrate on the potential incentives effects related to general economy-wide policies, aspects of government expenditures (fiscal expansionism) and the debt/interest rate problem.

4.6 Producer prices for agricultural exports can be influenced both by sectoral policies and macroeconomic policies. A World Bank study attempted to disaggregate these effects into direct (sectoral) and indirect (economy-wide) components to establish the relative importance of each (Krueger *et al* 1988). The direct effect simply measures the difference between the producer and border prices, suitably adjusted for marketing, transport, storage, etc.[1] However, Krueger *et al* (1988) demonstrate that the indirect effects from macroeconomic policies are also important and, in some cases, even more so than the direct effects. Their concept of indirect effects takes into

[1] Although not entirely consistent with the Krueger *et al* study, Table 3-1 has already given an indication of the direct effects on export commodity pricing from export taxation, government intervention in marketing and administered pricing -- it shows that typically there is a strongly downward pressure on producer prices. For cocoa in two West African states (Cote d'Ivoire and Ghana), the direct effects estimated by Krueger *et al* for the period 1980-84 vary widely: in Ghana, the producer price actually exceeded the border price by 34%, while Côte d'Ivoire's cocoa producers were penalized at a rate of 21%. For a further discussion of sectoral pricing policies and NRM see the previous Chapter.

account the prices of inputs, as well as the distortions arising from unsustainable current account deficits, various trade intervention effects on the exchange rate and trade barriers discriminating against agricultural tradables. By estimating a model which allows for the removal of these effects, the authors were able to assess their impact on export commodity prices, in addition to the direct pricing effects described above.

4.7 Again considering cocoa in West Africa, indirect effects are highly significant in the Krueger *et al* (1988) analysis, leading to a further 26% reduction of the producer price in Côte d'Ivoire, over and above the direct effect, while in Ghana the negative effect is much higher, at 89%. Indirect effects in Ghana actually overwhelm the positive direct effect, resulting in a total penalty on exported cocoa prices amounting to -55% of the border price. In Côte d'Ivoire, the total effect was -47%. By distorting prices and exchange rates, macroeconomic policies affected the allocation of natural resources and other inputs, thereby influencing NRM at the producer level. Although the exact magnitude of this effect is not known, the discussion of how distorted agricultural prices can affect NRM in the previous chapter provides guidance.

4.8 Distortions in economy-wide policies acting on producer prices certainly account for a significant influence on NRM, but this mechanism may be complicated by other parallel distortions. Mäler and Munasinghe (1996) argue that it is the presence of market, policy and institutional failures at the level of natural resource use itself, co-existing with inappropriate policies at the macroeconomic level, that explain land degradation. Such distortions may include underpricing of natural resources in the presence of externalities (see Chapter 3) or poorly defined property rights over these resources (see Chapter 5). If these market, policy and institutional failures did not exist, then the authors argue that general macroeconomic reforms would bring about improvements in NRM as well, or at least cause minimal harm. However, their presence may invalidate standard or 'first best' macro policy prescriptions for reform since such reforms may no longer be optimal. For example, monetary policy may be prescribed to correct a labour market imbalance and bring about full employment. However, an institutional failure in the resource sector, i.e. lack of property rights, may lead to a worsening degradation of resources as an unintended side-effect of the original macro correction, in which case the original prescription may no longer be the best policy choice. The authors refer to this problem as one of "macroeconomic environmental policy failure" and define it as follows:

> "A macroeconomic environmental policy failure occurs when macroeconomic policies, aimed at correcting one allocation failure (usually unrelated to the environment) result, at most, in a second-best allocation because of an accompanying deterioration of the environmental resource base (p. 155)."

4.9 In the relatively stagnant economies of West Africa, particularly prior to structural adjustment, such unintended side effects may have caused little harm to natural resources since economic activity was moribund and many policies ineffectual. However, Mäler and Munasinghe (1996) suggest that improving macroeconomic performance under instituted reforms (see next section) may raise greater concerns. If correcting for underlying failures in NRM is not possible, then a second-best approach may be called for, involving adjustments in macroeconomic policies to reduce the potential damages to NRM they might inadvertently cause if implemented unwittingly. Box 4-1 and 4-2 present case study evidence concerned with the comparative effects of fiscal and other policies on NRM, and this serves to illustrate some of the points made above, but also to highlight the sometimes contradictory results emerging from applied research.

Box 4-1 Modelling Macroeconomic Policies and Land Degradation in Ghana

In an important study, Lopez (1996) examines the case of macroeconomic policies in Ghana, estimating an empirical model in which biomass coverage on fallowed lands in the Western Region is treated as an input in a regional agricultural production function (10 villages). So defined, biomass serves as a measure of the fertility of soil, capturing the land regeneration function provided by fallowing -- as fallowed land biomass increases, agricultural output does as well. Lopez constructs a general equilibrium model to test the effects of various policy reforms on welfare and the fertility of land (as measured by its biomass coverage). These reforms are meant to correct for distortions at the general macroeconomic level, i.e. implicit taxation of agriculture, protection of manufacturing and fiscal expansionism, but co-existing with these are market or institutional failures at the NRM level. In the latter case, poorly defined property rights allow the overcultivation of land, as evidenced in the shortening of fallow periods below optimal lengths of time. Macroeconomic policies which encourage expanded agricultural output interact with this institutional failure, driving down the productivity of land, and offsetting any direct output effect arising in the first instance. Model runs were performed with and without this latter 'environmental distortion' taken into account. Results for a 5% improvement in each of the policy variables are indicated in Table 4-1.

As indicated by the results in Table 4-1 (see row 3), all policies lead to short run expansion of the cultivated area (extensification), at the expense of land regeneration. If the environmental distortion is considered, then tariff protection provides unambiguously negative impacts on welfare (as measured by national income), while fiscal reductions do the opposite. Reducing implicit taxation of the agricultural sector has an ambiguous result for welfare, depending on whether labour market distortions are corrected or not. There are also varying implications for agricultural wages. By not addressing the underlying institutional failure that permits overexpansion of the cropped area, the welfare effects of policy reforms are much reduced and inappropriate policy choices may be made. A similar case study result is reported in Box 4-4, where the effect of an exogenous change in the price of diamond exports from Botswana indirectly induces an increase in grazing pressure within the country, again abetted by institutional failures at the level of resource access and control (Unemo 1994).

Table 4-1 Effects of Policies on Macroeconomic Variables and Land Degradation in Ghana (% change)

Policy Effects on:	Net Reduction in Implicit Tax on Agriculture	Decrease in Tariff Protection to Industry	Decrease in Public Sector Employment or Wages
National income			
- environmental distortion	(0.02) – 0.21	(0.17) - (0.02)	0.07 - 0.22
- no environmental distortion	0.27 – 0.91	(0.13) - 0.91	0.03 - 0.24
Agricultural wages	3.36 – 4.55	(0.99) - (1.34)	(0.56) - (0.83)
Environmental resource level (e.g. biomass, fallow area)	(3.03) - (1.67)	(2.45) - (1.32)	(1.05) - (1.52)

Source: Lopez 1996
Notes: Ranges in values result from model runs which vary labour market conditions, considering a competitive labour market as well as rigidities as defined in the Harris-Todaro model; 'no environmental distortion' ignores long term decline in sustainable productivity induced by decreasing fallow periods.

4.10 The Ghana and Botswana case studies (Box 4-1) and the preceding discussion can be situated within a much broader policy controversy which concerns the efficacy of using general macro level or targeted environmental policies to address degradation problems. Numerous authors take the position that the preferred option is the latter, as in the correction of market and policy failures, since macroeconomic policies are much blunter instruments and are not directly targeted at environmental variables (Panayotou and Hupe 1996, Hansen 1996, Johnstone 1996, Low 1992). Mäler and Munasinghe (1996) appear to believe that complementary improvements in both arenas are most desirable. Similarly, advocates of 'green tax' reform see a need to replace

distortionary taxes on income and value-added with taxes on the depletion of natural resources and pollution, effectively reducing the taxation of what society wants more of and shifting the burden to what it wants less of, according to Daly (1996). Such reforms are argued to produce a 'double dividend', improving NRM as well as generating economic efficiency benefits of a more general nature -- simultaneously correcting for distortions on incomes and production as well as the underpricing of natural resources.

4.11 However, as the additional study presented in Box 4-2 shows, even policies aimed directly at correcting market failure have extensive effects throughout the economy and may not, in the end, produce a more desirable result. This study also finds that trade liberalization may be beneficial for NRM, when differences between lowland and upland farming are taken into account. Furthermore, studies such as that of Larson and Bromley (1990), who model the incentives to degrade facing smallholders under private and common property regimes, demonstrate that the modification of property rights in response to perceived market failure may matter less than "poverty, poor resource endowments, and a fragile ecosystem" (p. 256). Thus, calling for the correcting of institutional failures through blanket prescriptions, such as privatizing resource ownership, may be less effective than implied by the studies cited above. We pursue this line of argument in more detail in the next chapter.

Box 4-2 Impacts on NRM of Alternative Macro and Sectoral Policies

Coxhead and Jayasuriya (1995) examine the effects of several policy options for their impacts on upland annual food crop production. They assert that these production systems are highly erosive in comparison to the alternative of growing less erosive perennial tree crops. Their main contention is that the indirect effects of well-meaning environmental policies could diminish or even reverse the intended impacts of these policies on NRM and that desired NRM objectives could be achieved just as effectively via indirect effects instead. To undertake their analysis they construct a *general equilibrium model* of a representative developing country economy, which includes four sectors: lowland-based manufacturing, lowland food production, upland food production and upland tree crop production. Manufacturing is assumed to be import-substituting and, therefore, protected by tariffs. Lowland and upland food crops are assumed to be nontradables with an endogenously determined price; they are also substitutable, and thus their production can be aggregated to meet consumption demand. Tree crop production is for export, with an exogenously determined price. All producer prices are adjusted for the effects of taxes and subsidies. The model takes into account the impacts of policies on general price levels, wages and returns to land, land areas devoted to tree versus food crops and other measures of economic performance and NRM.

The authors consider policy options for improving NRM, but only in terms of crop-switching. They do not allow for investment in soil and water conservation measures nor take into account property rights arrangements and potential induced technology effects. To test the relative strengths of each policy, they use data for a representative developing country economy (mostly from the Philippines) and simulate the responses to each policy. Four policies are examined, all with the express purpose of reducing the extent of erosive, upland cropping:

- a 10% export subsidy on tree crop production to encourage expanded output at the expense of food crops;
- a 10% tariff reduction (in the rate of protection) for imports competing with manufactured goods, which would reduce this sector's output and shift labour into lowland crop production, thereby reducing the demand for upland food production;
- a 10% production tax on upland food production intended to correct the externality created by off-site damages from soil erosion, i.e. 'internalizing' the externality; and,
- a 10% subsidy on lowland food production to improve its relative position vis-a-via upland food production.

They find that all policies achieve the desired result of reducing upland cropped area, but not to the same extent. While the first three measures variously reduce upland cropped area by 12 to 18%, the fourth causes only a 3% contraction. Each policy increases real aggregate output in the economy, real household incomes and real returns to land in the upland zone. However, 'direct' environmental policies, such as a production tax on upland agriculture, have disadvantages vis-à-vis macroeconomic options, such as tariff reductions -- for example, the former lead to an increase in general prices while the latter does the opposite. In addition, imposing production taxes on upland farmers is hardly realistic, given the difficulties of administration and hardship imposed. The use of subsidies has the added burden of increasing government expenditures, again difficult in view of the fiscal limits facing most developing nations. Furthermore, all four policies reduce real wages in the upland area, which has a more general distributional effect, arguably exacerbating impoverishment and possibly encouraging the poverty-degradation trap referred to in Chapter 2.

4.12 We turn now to a brief analysis of the variable incentives effects of selected fiscal and monetary policies on NRM.[1] We have earlier made the point that under-financing of operating and maintenance (O&M) for irrigation systems and other structural works, can be responsible for deterioration in their effectiveness, leading to direct degradation and a lack of incentives for proper management on the part of users (see Chapter 3). Such thinking can be applied more widely, to other infrastructure sectors where inadequate budgetary allocations can lead to the same result (e.g. road planning and maintenance, health system expenditures).

[1] Policies specifically targeted at creating an enabling environment through informal credit availability and appropriate research and extension are covered in the next chapter.

4.13 Nonetheless, where expenditures on infrastructure have been made, these appear to have had a statistically significant influence on agricultural output, and hence on NRM, through the various channels linked to changes in output that were discussed in the previous chapter. In a large cross-country study, Binswanger (1990) estimates elasticities for aggregate crop output with respect to rural road quantity and quality ranging from 0.12 to 0.26. Significant changes in input use associated with road improvements have also been found by Binswanger; fertilizer use responds to road improvements similarly to aggregate output, while a much larger tractor stock response is evident (1.71). The direct consequences for NRM from these particular input changes is largely negative, as we have discussed in Chapter 3. Road building can have other less obvious impacts on NRM, as demonstrated by Fox's study of a small rural area in the hills of Nepal, where the penetration of the road network was seen as the most important contributing factor to local degradation and deforestation over a 10-year period (Fox 1993). Road access also reduces the costs of marketing commercial crops and should improve their net returns vis-à-vis subsistence production, leading to crop switching, deforestation and penetration into frontier areas which were previously inaccessible (Gupta *et al* 1995). In the case of crop switching, the net effect of these activities on NRM depends on the crops involved.

4.14 Infrastructure spending can affect NRM in the pastoral sector, especially in light of the trend in West Africa towards trucking and rail transport of livestock intended for export, and diminished use of 'trekking' (Holtzman and Kulibaba 1996). This transition in the means of transport reflects the difficulties faced by pastoralists in moving livestock along once traditional routes to the coastal ports. Conflicts with encroaching sedentary farmers -- where mutualistic fodder-manuring arrangements were common previously (e.g. Northern Nigeria) -- and reduced access to forage and water have occurred. The consequences of this situation are not only poorer animal health upon arrival, but also land degradation en route. Accordingly, public investments in road and rail infrastructure help to alleviate these stresses and support the aims of an *opportunistic management* strategy which calls for rapid marketing responses to changing rangeland conditions (although trekking will continue to be important for many herders).

4.15 Despite limited spending on some types of infrastructure, most governments in Africa have been associated with highly expansive fiscal policies and the resulting macroeconomic imbalances have had serious consequences for economic stability (Lensink 1996). Uncertainty arises from instability, and its consequences for farm level investment in improved land management are discussed elsewhere. High debt service ratios encourage expanded export production, and this can harm NRM if it involves expansion of these activities onto marginal and fragile lands. It also reduces the options available to governments for reducing distortions in the economy, especially where these are relied upon to generate foreign currency. Thus, the scope for policy failures with negative consequences for NRM is enhanced.

4.16 Linked to the expansive fiscal policies and external debt of many developing countries discussed above, is the action of the interest rate policy on NRM. Countries within the CFA franc zone have maintained relatively stable monetary environments, with annual monetary growth averaging less than 10% per annum during the 1980s and lending rates pegged at 8.8% in 1990. In contrast, West African countries outside the franc zone often show greater monetary growth -- Ghana's annual expansion in the money supplied averaged 45% over the same decade -- and higher lending rates, with the latter standing at an average 18.6% in 1992 (World Bank 1992). High interest rates may be symptomatic of broader macroeconomic instability, leading Munasinghe (1996) to observe that "high interest rates associated with economic crises can severely undermine incentives for sustainable management of resources, as producers seek to maximize current yields at the expense of future outputs." (p. 204).

4.17 Despite the incidence of high interest rates under severe crisis circumstances, most developing countries have tried to maintain relatively low or even negative real interest rates to promote industrial development (Todaro 1994). However, formal credit policies have tended to be highly selective, with only about 5% of African farmers actually availing themselves of formal credit (Gonzalez-Vega 1984). Instead, many smallholders excluded from the formal credit market are forced to obtain credit from informal sources at rates many times higher than subsidized formal rates. In the presence of these conditions, several NRM effects can be observed. First, fixing low real interest rates has an impact on overall macroeconomic balances through its effect on inflation, which is the main macroeconomic response in the face of the sluggish industrial response to cheap credit in many countries (Todaro 1994). Unfortunately, *a priori* it is difficult to predict how changes in general price levels, as opposed to relative prices, will influence NRM except to suggest that high inflation discriminates against the poor and can induce impoverishment and overexploitation of natural resources. In addition, we have already noted that investments in land extensification may serve as a hedge against high inflation.

4.18 Second, and perhaps more importantly, controlling interest rates forces a rationing of credit and it is usually larger, wealthier farmers who benefit (Southgate 1988). Gonzalez-Vega (1984) discusses the income distribution implications of credit rationing and the extremely high interest rates charged by informal moneylenders. The high costs of credit facing smallholders are liable to influence private discount rates, although there is some evidence from the Philippines to dispute this well-established economic principle (Lumley 1997). As we have already discussed in the previous chapter, marginalization of the poor results in high private discount rates and has negative implications for NRM, chiefly through the way in which it discourages longer term planning and investment in conservation technologies. Further discussion of the user enabling aspects of access to informal credit and special smallholder credit programmes is provided in the next chapter.

4.19 There is some empirical evidence to support the notion that reforming formal credit institutions, leading to expanded credit and lower interest rates to producers, can reduce degradation. In a CGE model of the Costa Rican economy, Persson and Munasinghe (1996) show that lower interest rates prevailing in the economy lead to less deforestation. In a study of farmers in the Amazon, Schneider (1995) shows that in the presence of Brazil's very high real interest rates, farmers choose agricultural practices that have high initial returns but subsequently lead to decaying productivity.

Trade and Exchange Rate (External Sector) Linkages to NRM

4.20 The link between trade and the environment has been examined by many researchers in recent years, much of this work documented in special issues of key academic journals or in the publications of international agencies.[1] However, much of this literature is broad in scope, addressing such issues as transboundary pollution, trade agreements, trading standards and regulations, etc. Relatively few researchers have considered the implications of trade for the management of natural resources, particularly at the farm level (Low 1992). Exceptions include studies of trade liberalization and its implications for NRM, discussed in Section 4.3, and the analysis of the environmental impacts of trade reforms under structural adjustment, reviewed in

[1] Some examples of special issues on trade and environment include: Ecological Economics 9 (1) 1994; American Journal of Agricultural Economics 75 (August 1993); World Economy 15 (1), 1992; World Development 19 (1) 1991; World Bank (1992). See especially Low (1992) for a brief but useful overview of the topic.

the next section. In this section, we confine ourselves largely to the role of protectionist policies and exchange rates in affecting NRM at the household level.

4.21 Many African countries are reliant on the export of just a few agricultural export commodities for their foreign exchange earnings, most of these crops having been discussed in various contexts in earlier sections (e.g. 'cash' crops, gender effects, erosion risk, etc.). As the data in Table 4-2 show, cotton, cocoa and hides and skins have historically dominated the exports from West African countries in this position, while coffee, tobacco, timber and sugar have been important in other African countries. To meet their foreign exchange obligations, these resource-dependent nations must support production of these exportable crops, for which they have a comparative advantage. As we have already seen in Chapter 3, cotton can be highly erosive, while cocoa and coffee are much less so; in contrast, hides and skins exports are associated with pastoral production and when exports stimulate higher offtake rates, this can be favourable for NRM, but if export promotion induces higher stocking levels with no corresponding increase in offtake rates, NRM may suffer.

Table 4-2 African Countries with High Export Concentration in Predominantly Agricultural Export Commodities in the Early 1980s

Countries	Contribution of Primary Commodities to Exports* (%)	Main Export Commodities: First **	Second **
West Africa:			
Benin	50.8	cotton (20.7%)	cocoa (14.2%)
Burkina Faso	50.6	cotton (45.0%)	hides/skins (4.0%)
Chad	65.1	cotton (60.7%)	hides/skins (4.5%)
Côte d'Ivoire	67.1	cocoa (24.2%)	coffee (19.4%)
Other African:			
Burundi	98.5	coffee (91.2%)	cotton (2.8%)
Central African Rep.	63.2	coffee (28.7%)	timber (25.4%)
Equatorial Guinea	95.4	cocoa (71.5%)	timber (18.5%)
Ethiopia	71.7	coffee (61.5%)	hides/skins (16.9%)
Malawi	91.9	tobacco (49.8%)	sugar (19.8%)
Rwanda	94.7	coffee (66.6%)	tin (17.0%)
Tanzania	60.0	coffee (29.8%)	cotton (13.3%)
Uganda	98.0	coffee (94.0%)	cotton (1.8%)

Source: Barbier 1988
Notes: (*) calculated in terms of percentage contributions of 33 most important commodities to value of total merchandise exports; (**) figures in brackets are contribution to value shown in second column.

4.22 Governments have displayed pessimism about the role of markets through the use of parastatal marketing agencies for key export crops and supported infant industries or crops for import substitution, sometimes requiring a protectionist stance (Cleaver 1985). For example, imports of rice into Ghana were directly penalized at a rate of 118% of their border price during the period 1980-84, while in Côte d'Ivoire the protection rate was lower, at 16%, but still significant (Krueger *et al* 1988). In West Africa, rice production involves irrigation with its inherent problems for NRM, as discussed in the previous chapter. Nigeria has also protected irrigated wheat production in the North with the consequences for wetland resources documented in Box 3-4. Thus, protecting domestic production can encourage unsustainable agricultural activity. Instead, establishing producer prices in relation to border prices is usually recommended

for economic efficiency purposes.[1] There is an additional aspect to protecting domestic agriculture: Sub-Saharan African countries have relied heavily on import duties and export taxes to finance government expenditures. Rimmer (1984) argues this is because of: "...the facility with which import and export duties can be collected, and the high proportions of economic rent in the value of some mineral exports, especially oil." (p. 200). Thus, the options for reducing tariffs and export taxes as a policy measure has been limited, with the consequences for NRM implied by lower net returns for producers discussed in the previous chapter and elaborated below.

4.23 It has often been argued that protectionism on the part of Western economies has been an additional cause of the economic and environmental crisis in Africa (Lensink 1996). Young (1993), for example, suggests that the world's savanna regions have a comparative advantage in livestock production but suffer from the protectionist policies of trading nations. However, a review of the conditions governing trade between Africa and the West reveals that the situation is complex and not so easily characterized. African products destined for Europe -- where about 50% of all African exports go -- are essentially free of tariffs, under the preferential terms of the Lomé Convention. Exports to the U.S. and Japan are similarly treated favourably. In a study of the levels of protection exerted by Western economies against African and other developing country exporters, Erzan and Svedberg (1989) show that African nations face tariff barriers which are only 40% of the average for all LDCs in the Japanese market, and 7% of the average for all LDCs when exporting to the U.S. market. The differences are much less marked with respect to non-tariff barriers (NTBs), with the advantage even reversed in the case of Japan. Results from their study for selected West African countries and Africa versus other LDCs are presented in Table 4-3.

Table 4-3 Tariff and Non-Tariff Protection from the EC, Japan and the USA

Region/ Countries	EC Tariffs*	EC NTBs**	Japan Tariffs*	Japan NTBs**	USA Tariffs*	USA NTBs**
Côte d'Ivoire	0.00	2	0.20	0	0.10	2
Ghana	0.00	0	0.40	9	0.00	0
Nigeria	0.00	0	2.60	86	0.70	0
Africa	0.01	23	1.64	17	0.48	2
All LDCs	1.76	29	4.03	8	6.67	14

Source: Erzan and Svedberg 1989, reported in Lensink 1996
Notes: data for individual countries is for 1986 while regional data is 1983; (*) values are for actual tariff rates, including preferences; (**) measured as the trade coverage ratio, which is the ratio of the value of imports affected by NTBs to the total.

4.24 Ironically, it has been argued that these preferential trade agreements may actually contribute to degradation (Yaeger 1989). With respect to savanna NRM, Young (1993) argues that they may favour only a few larger operations, as has happened with beef production and export in Botswana. The vast majority of pastoralists have not benefited, and there are suspicions that degradation has worsened, since the Lomé Convention: "...aggravates the adverse impacts of inappropriate government investments in infrastructure development and tenure arrangements" (p. 85), that we have discussed above.

4.25 A more important trade-related problem in West Africa, indeed in all of Africa, has been the overvaluation of exchange rates (Cleaver 1985), although it is necessary to distinguish

[1]Perrings (1996) points out that border prices actually underestimate true resource costs because of distortions in the international trade system, so that 'getting the prices right' can be difficult. This topic is discussed in more detail along with trade liberalization issues.

members of the CFA franc zone from nations outside of it. Lensink (1996) provides a useful discussion of exchange rate conditions in Africa and much of the following is based on his account. Amongst the non-CFA countries, substantial periods of devaluation have predominated since 1980, in efforts to correct a situation of serious overvaluation. For example, the Nigerian Naira and Ghanaian Cedi have risen by about 500% since that date, when measured on the basis of real effective exchange rates, which take into account prices and volumes of trade with different countries.[1] Paralleling official exchange rates have been substantial 'black markets' for foreign exchange with hefty premiums on foreign currency: Nigeria's black market exchange premium stood at 129% in 1993.

4.26 Within the CFA franc zone, circumstances are different, since member country's monetary policy is linked with that of France. In return, the countries have experienced generally low inflation but have been unable to use their exchange rates to buffer external commodity price changes affecting their terms of trade. Over time, inappropriately expansive monetary policies created a serious problem of overvaluation for even these countries, which was eventually recognized by the IMF as needing attention. The situation was not formally addressed until a 100% devaluation of the CFA franc was imposed in 1994, along with the forgiving of various debts accumulated with the Central Bank of France.[2] Such a large one-shot devaluation would be expected to have dramatic and immediate impacts on prices, although Pearce *et al* (1988) warn that:

> "This may have little impact on farmer's incentives due to the presence of middlemen, district traders, processors and trading monopolies. This network of intermediaries may soak up the benefits to exports of any devaluation, leaving producer margins little changed. In effect, the devaluation creates a 'rent' which is dissipated by those with economic power, leaving the farmer unaffected." (p. 21)

4.27 With respect to NRM, overvalued exchange rates behave much like artificially low producer prices, discouraging agricultural output and the adoption of conservation technologies. The full impact can be traced using Figure 3-1 but would involve all the qualifications discussed in the previous chapter with respect to changes in agricultural prices and NRM. Conversely, devaluing will have an impact similar to the raising of producer prices. Thus, depending on whether crops are tradable or not, there may be incentives to crop switch in response to overvaluation (e.g. cotton to cassava) or devaluation (e.g. vice versa).

4.28 When currencies are overvalued, there can be numerous additional impacts on NRM. For example, there can be strong incentives to smuggle agricultural inputs and outputs across borders, affecting their availability in the home country -- fertilizers and petroleum products are typically involved. Young (1993) considers the specific effects of overvaluation for savanna-based production systems, such as those prevailing in Sahelian West Africa. Although these regions depend upon exportable commodities, which are admittedly erosive in many cases, the diminishing of export opportunities as a result of overvaluation can reduce land values as well as the profits of resource-conserving technologies (see Southgate 1988). In addition, imported production inputs, like tractors and fertilizers, become cheaper because of the lower import cost

[1] The real exchange rate measures domestic purchasing power relative to purchasing power abroad and accordingly links exchange rates with domestic and international price levels (see Table 4-4 for a more precise definition of the real exchange rate).

[2] We use the term 'formally' to differentiate an official devaluation from the 'mock' devaluations practised by some countries, particularly Sengal and Côte d'Ivoire, through the subsidizing of exports and imposition of additional import tariffs, to mimic the effects of a formal devaluation (Lensink 1996).

and displace more sustainable alternatives (see Chapter 3). Young notes that pastoralists can be especially hard hit since they make use of few imported inputs and thus their terms of trade deteriorate vis-à-vis cropping, potentially leading to their displacement by settled agriculturalists. For these reasons, he concludes that overvaluation has mostly negative implications for savanna land management.

4.29 While overvaluation has been the key trade issue in West Africa's recent history, even normal fluctuations in exchange rates under prevailing market supply and demand conditions can affect NRM. Again, these movements in exchange rates will affect NRM similarly to the effects of changes in producer prices, although the strength of this response may be quite different. Several studies have considered the responsiveness of agricultural variables to changes in exchange rates. Jaeger (1992) obtains elasticities for the output of various individual crops and crop combinations for assorted groups of Sub-Saharan African countries with respect to real exchange rates. Values range from -0.10 to -0.68, with cotton at the top of the range, although Mamingi (1997) warns of some methodological concerns with this study. Pick and Vollrath (1994) find output-real exchange rate elasticities of -0.18 to -0.78 for several Latin American and African countries, with cocoa production in Nigeria at the lower end of the range indicated. These values compare favourably with the relatively high price elasticities of supply for individual crops shown in Table A2-1.[1]

4.30 Many factors can influence movements in the 'real' exchange rate, and thus indirectly affect the pattern of agricultural production and, ultimately, NRM. Table 4-4 describes the varied impacts on the real exchange rate emanating from different policy and external influences (the variables). Interpreting from the table, certain developments cause an appreciation of the real exchange rate (e.g. rising productivity or interest rates, etc.) and will discourage exports and other tradables, vis-à-vis the non-tradable sector. Changes in variables leading to a depreciation (e.g. capital outflow or devaluation in the nominal exchange rate) will do the reverse. The link between these key economic variables and their potential outcomes at the NRM level may be deduced as discussed above, subject to the qualifications raised earlier.

[1] Binswanger (1990) argues that agricultural exports in Sub-Saharan Africa respond to real exchange rates much more strongly than does production in other sectors. Elasticities for the ratio of agricultural exports to total agricultural output are cited at 1.35, and for the ratio of net agricultural exports to total agricultural output a sizeable 11.5 is reported (Balassa 1986). Thus, a one percent depreciation in the real exchange rate results in an increase in the share of total agricultural output exported as noted here. Net exports respond more strongly because they also take into account reductions in imports once their domestic prices rise because of the depreciation.

Table 4-4 Expected Changes in the Real Exchange Rate in Response to Various Influences

Explanatory Variable	Effect on the Real Exchange Rate
Productivity increase	Appreciation
Increase in fiscal deficit	"
Increase in money supply	"
Decline in foreign real income	"
Deterioration in the terms of trade	Depreciation
Increase in world interest rate	"
Capital outflow	"
Devaluation	"

Source: Diakosavvas and Kirkpatrick 1990
Note: The real exchange rate is defined as the nominal exchange rate deflated by some measure of relative prices at home versus abroad.

B. STRUCTURAL ADJUSTMENT PROGRAMMES (SAPS) AND NRM

4.31 The performance of Sub-Saharan African economies over recent decades has been almost universally disappointing. GDP growth over the period 1970 to 1980 averaged 3.6% annually and was about equal to growth in South Asia, but lagged behind East Asia, where a rate of 6.6% prevailed. However, during the 1980-92 period, African growth fell to an average annual rate of 1.8%, compared to rates of 7.7% and 5.2% in East and South Asia, respectively (Lensink 1996). On a per capita basis, the high birth rates characterizing Africa result in an even more disappointing performance (see Chapter 2). Along with poor GDP growth records came a declining rate of export growth, except for an occasional spurt of activity, as occurred with Ghana in the late 1980s. On the investment side, a low level of savings characterizes Africa, along with poor capital productivity (Lensink 1996). Mounting debt burdens made it increasingly difficult for African nations to meet their obligations, culminating in a 'debt crisis'.

4.32 In response to these problems, the key international lending institutions, i.e. IMF and World Bank, established a series of Structural Adjustment Programmes (SAPs) for a number of African (and other) countries, comprising various reforms and conditionalities supported by large adjustment loans. These programmes involve macroeconomic, trade and sectoral reforms, many of which have been discussed on an individual basis elsewhere in this report. Rather, it is the integration of numerous policy changes under a single programme which marks out SAPs as being of interest for NRM, and it is this aspect which we concentrate on here. As it is not the purpose of this study to consider SAPs in detail, we provide a brief overview in the Appendix to Chapter 4 and refer readers on to more detailed studies of the topic.

4.33 The objectives and nature of structural adjustment have varied, according to the country in question and the financing institution behind it. However, most programmes have initially been targeted at alleviating balance of payments and government deficit difficulties, while engendering a more stable economic environment within which long-term growth would be encouraged (World Bank 1988). Key policy areas addressed under the programmes include trade, the agricultural sector and public sector management. However, trade has tended to be the most important (Lensink 1996). In the language we have used thus far, SAPs are liable to include measures that affect both variable and enabling incentives, but we will concentrate primarily on the former. Figure 4-1 shows how the various sectoral and macroeconomic policy reforms under adjustment interact.

4.34 Not surprisingly, the wide range of policies affected by a SAP makes it difficult to isolate specific linkages between individual policy changes and their NRM effects. Thus, drawing rigorous conclusions as to the impacts on NRM is difficult. Furthermore, many of the desired effects of adjustment can only materialize in the long run, and it is generally accepted that there may be short-term economic, social and perhaps environmental costs. Thus, environmental impacts are liable to differ over longer versus shorter periods of analysis and in the former case, there is unlikely to be sufficient data as yet to enable conclusions to be drawn. The complexity of adjustment and pervasiveness of its effects has not stopped some critics and supporters from adopting rather naive positions on the subject -- increasingly, more rigorous analysis is coming to light which takes a more cautious, middle-of-the-road position. We first review some of the hypothetical impacts on NRM anticipated from adjustment, and then review evidence from several West African case studies. We can direct our discussion by considering the effects that SAPs may have on various indirect incentives and then refer back to earlier discussions as to how these changes may influence NRM.

4.35 Outside of the more direct NRM-related measures described in Box 4-3, adjustment will have other less immediately obvious implications for NRM. Although referring to stabilization (a broader concept than adjustment on its own), Steer (1996) provides a useful framework for assessing the hypothetical impacts of adjustment. He broadly groups these impacts into four categories: relative price shifts; reduced aggregate demand within the economy; associated institutional reforms, such as in the financial sector; and, the effects of stabilization, i.e. through lower inflation rates and reduced macroeconomic imbalances.

Box 4-3 Environmental Aspects of Adjustment Loans in West Africa (FY1988 to 92)

Some West African SAPs contain explicit measures of an environmental nature intended to improve the incentives for soil conservation. For example, a recent World Bank study identifies five countries where such objectives are tied to better land tenure security or titling (e.g. Benin, Burkina Faso, Côte d'Ivoire, Mali, Mauritania). More direct SAP measures affecting soil and water conservation in West Africa identified by the study's authors include the following:

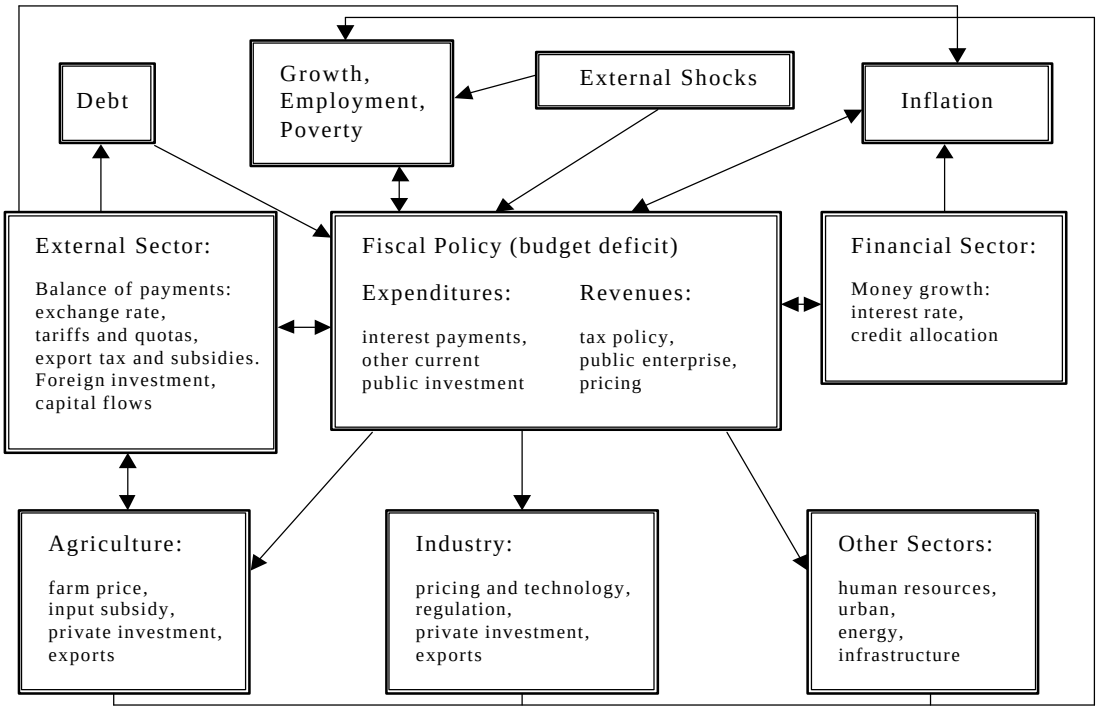
- promotion of environmentally safe use of fertilizers and pesticides through research and extension, etc. (e.g. Ghana);
- improved cultivation practices for soil erosion prevention/watershed protection via terracing, cropping patterns, etc. (e.g. Ghana, Mali);
- agropastoral development or integration of livestock and crop production (e.g. Burkina Faso, Ghana, Mali, Mauritania);
- desertification control and rangeland management (e.g. Burkina Faso, Mauritania); and,
- irrigation development (including improved O&M) and flood control (e.g. Mauritania).

Source: Warford *et al* 1994

4.36 Pearce and Warford (1993) review a study by Sebastian and Alicbusan (1989) involving a large sample of countries under adjustment, noting that in 23 of 43 cases examined, adjustment resulted in higher agricultural prices. They observe that the increases tend to be for perennial crops with beneficial soil qualities -- examples include bananas, cocoa, coffee, palm oil, rubber and tea -- while potentially erosive subsistence food crops such as cassava, maize, millet and sorghum, are less likely to have experienced price increases and, in some cases, actually show price declines. Export tax reductions and currency devaluations are generally the source of the price effects but are partially offset in some situations by the removal or reduction of input subsidies. Impacts of the latter on NRM are discussed in the previous chapter. In Malawi, raising the export tax on tea, itself not necessarily erosive, had the effect of reducing production and, consequently, the demand for fuelwood (and deforestation) for curing. However, other reviews of

Malawi's experience with adjustment suggest that pricing incentives policies were largely unsuccessful (Sahn and Arulpragasam 1991).

Figure 4-1
How Structural Adjustment Policies Interact



Source: World Bank 1988

4.37 Adjustment objectives other than the direct reform of relative prices and cropping patterns may have effects on NRM; some authors suggest these effects, while more indirect, may be even more substantive. For example, the financing of rural infrastructure and marketing improvements can have implications for NRM by indirectly increasing the net returns of tradables vis-à-vis subsistence food crops, which is often one of the main objectives of adjustment (Binswanger 1990). Furthermore, Table A4-2 shows that in some West African countries, SAPs have had negative repercussions for health and nutritional status (e.g. Nigeria), which can reduce labour productivity. Together with declining real incomes in the short run for some segments of society as a result of adjustment, these developments can lead to greater impoverishment and accentuate the poverty-degradation trap, as discussed in Chapter 2. Public expenditure cutbacks in education and research/extension can similarly have indirect effects, by reducing the production and transmission of knowledge about improved land management practices, which is central to the land husbandry view of NRM (see the next chapter). Additional theoretical issues arising with respect to SAPs and agricultural output or NRM are discussed in Box 4-4.

Box 4-4 Theoretical Effects of SAPs on Agricultural Output and NRM

Binswanger (1990) notes that SAPs should improve the terms of trade facing agriculture as a whole but also change relative prices within the sector in favour of tradables. Consistent with this view, many SAPs in West Africa emphasize the promotion of export crops, which include cocoa, cotton, coffee, tobacco, groundnuts and several others (see Box 4-5). Shifting agricultural production towards export crops in the semi-arid zone of West Africa means encouraging potentially erosive crops, while in the forest zone, where cocoa and coffee are prevalent, this may have fewer negative consequences for NRM. As we have noted in Chapter 3, males often hold the responsibility for managing cash crops in Sub-Saharan Africa. Smith (1994) points out that by concentrating on expanding cash crop production, SAPs may have gender implications as well as repercussions for NRM. In general, adjustment policies are seen as bypassing many rural women, as their control of factors of production is rather limited, thus inhibiting their response to changes in variable incentives. Instead, with adjustment primarily targeted at market activity, it is normally males who may be in a better position to respond, especially in the export crop sub-sector (Haddad *et al* 1995).

Binswanger (1990) also addresses the question of whether SAPs stimulate overall agricultural production rather than simply shifting productive resources from domestic food production to export crops. We have already seen that agricultural output in sub-Saharan Africa can be quite responsive to a depreciation in the real exchange rate (see previous section). However, per capita food production seems not to respond so dramatically, if at all. Binswanger reasons that the removal of import restrictions (protection) on food staples and exchange rate reform, combine with lower food demand under adjustment (due to falling real incomes) to leave food prices relatively unchanged in the short run. With no increase in food prices to stimulate increased production, there is little production response. Overall, he feels that the aggregate supply response under adjustment would be limited in the short run and only materialize in the longer term.

Figure 4-2 summarizes the above arguments. Although the implications for NRM are not shown in the figure, they can be surmised from earlier discussions in Chapter 3: reduced input subsidies and a poor aggregate supply response suggest that negative extensification and intensification effects would be weak or non-existent, cash crop production would respond to higher prices and expand with crop and location-specific impacts (see above) and there would be relatively little impact in the food crop sub-sector (see Figure 3-1 for a summary of price effects).

4.38 Based on a series of case studies, Reed argues for more analyses of the indirect effects of SAPs on NRM incentives, which he feels generate more significant environmental impacts:

> "...the impact of price changes on the environment is uniformly insignificant relative to the impact of structural adjustment on social structures and institutions. In my opinion, we need to broaden our discussion and begin looking at these issues -- that is, not just focus on the direct links between one instrument (or a package of instruments) and a particular environmental problem, but to understand how the effects of these instruments are transmitted to social structures and institutions and, as a consequence, how they fundamentally alter the rate and composition of natural resource use in developing countries." (Gandhi 1996, p. 71)

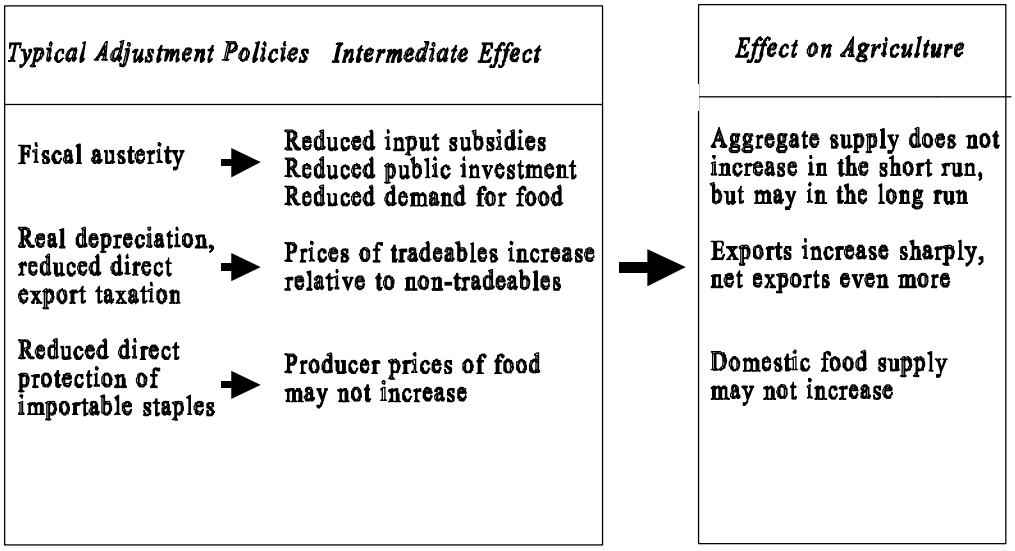
4.39 Finally, if a SAP represents one component in a broader stabilization programme, then there may be benefits for NRM from the attainment of a more stable policy and economic environment. Steer (1996) notes that if macroeconomic stabilization is successful then by definition it should create a more positive environment for risk at the household level and hopefully reduce price or net returns volatility. We have already argued that non-systemic variability in prices, or 'price risk', can deter farmers from making conservation improvements (see Chapter 3). Moreover, if reform of the financial sector succeeds in replacing high and unstable interest rates with lower and more stable ones, then there should be a downward and stabilizing pressure on private discount rates, with benefits for the net returns from conservation as discussed in Chapter 2 (Gandhi 1996). Unfortunately, relatively little such analysis has been undertaken to date on non-price aspects of the adjustment-environment linkage.

4.40 We turn now to a review of several case studies relating to adjustment and the environment in West Africa, including Box 4-5, which considers the specific situation of cocoa production in Ghana.[1] In perhaps the most comprehensive set of case studies of structural adjustment and the environment, Reed (1992, 1996) looks at a wide range of NRM effects in twelve countries, of which three are West African, i.e. Côte d'Ivoire, Cameroon and Mali.[2] Table 4-5 summarizes the main findings for all three countries and a brief discussion of the results is provided below. The major SAP impacts in these West African countries involved responses to devaluation (this did not come to Mali and Côte d'Ivoire until 1994) and trade reforms which revamped the producer incentives for cash crops such as cocoa, coffee and cotton production, although much less so in Côte d'Ivoire.

[1] Also see Panayotou and Hupé (1996) for an extensive review of case studies on the environmental impacts of SAPs.

[2] As this research was supported by the World Wide Fund for Nature, its perspective may be anticipated to be somewhat partisan. Although there is an emphasis on the negative aspects on SAPs to some extent, it does try to recognize that many impacts are liable to be ambiguous and there is some acknowledgement of the benefits for the environment from adjustment. For a further discussion of this research, see an upcoming book review in the Journal of Environmental Studies.

Figure 4-2
Predicted Effects of Structural Adjustment Policies on Agriculture



Source: Binswanger 1990

Box 4-5 Case Study: Structural Adjustment and Cocoa in Ghana

Ghana's SAP, adopted in 1983, heavily emphasized promotion of cocoa exports, in light of its rapidly declining position in the world market over the previous two decades. Aside from a heavily overvalued exchange rate, producers had been further burdened with high export taxes on cocoa, so that the prices they received were much lower than in neighbouring countries exporting cocoa. Barbier (1988) points out that despite a 90% devaluation and a threefold increase in the producer price of cocoa, poor international market conditions prevented cocoa output achieving its targeted level of 300,000 t/yr in these early years of adjustment. Nonetheless, the SAP has had some impact on production, with production more recently running at 240,000 to just over 300,000 t/yr (1991-93). Barbier observes that the implications for NRM are uncertain: some smallholders in benefiting from increased cocoa prices may have had less incentive "for overextensification of food production out of sheer poverty" (p20), while the improving incentives for cocoa may have encouraged its expanded production into new, and possibly fragile areas. Cheru (1992) argues that Ghana's adjustment process has unduly favoured cocoa farmers – who comprise just 18% of the farming population -- with too little emphasis on support for food producers, and has "aggravated poverty, income inequalities and environmental degradation." (p507). We have already noted in Chapter 2 that inappropriate incentives facing cocoa growers have led to encroachment into the forest zone of western Ghana (and western Côte d'Ivoire); in part, these movements have resulted from a structure of incentives which favoured frontier development of new cocoa areas over the rehabilitation of traditional cocoa lands (FAO 1992, Benneh 1988). However, more recent FAO data indicate that the total harvested area of cocoa has declined from its 1979-81 average of 1.2 million ha to about 1.0 million ha. Thus, a general extensification of cocoa seems not to have occurred. As cited above, international price developments may have been a factor (see Figure 4-4).

4.41 Côte d'Ivoire's adjustment record has been relatively poor so that modest increases in producer prices for cash crops were overwhelmed by international price declines.[1] Moreover, encroachment into frontier areas was further dampened by a reduction in public expenditures on infrastructure (e.g. roads). In Cameroon, improved producer incentives were manifested in the rehabilitation of environmentally benign cocoa plantations but also in the expanded cultivation of more erosive cash crops like potatoes. In Mali, cotton producers were previously well-protected from market fluctuations and incentives for expanded production only emerged with devaluation. In the livestock sub-sector (e.g. Mali), higher prices stimulated an upsurge in sales but this was anticipated to be a short run phenomenon only, as livestock owners eventually could be expected to invest new income in expanding their herds, threatening further grazing pressure (also see Perrings 1996, for discussion of a similar effect in Botswana).

[1] Despite this finding, more recent data would argue otherwise. FAO data show that Côte d'Ivoire's cocoa production nearly doubled over the period 1979-81 to 1991-93, as a result of a 20% increase in yields, accompanied by a 50% increase in the area harvested. International prices cannot account for the strong performance, since in the early 1990s these were only about one-third their real value in 1980. The reasons for the discrepancy with the WWF report's view of the effect of adjustment on cocoa are not readily apparent. Clearly, there are grounds for some of the NRM concerns cited by Barbier in Box 4-5 concerning cocoa extensification.

Table 4-5 Structural Adjustment- Environment Linkages in Three West African Countries

Adjustment Components	Impacts	Comments
Cameroon:		
Cuts in farmer support facilities (e.g. input subsidies, extension services)	+/-	Discouragement of more intensive farming, diversification, conservation and agroforestry
Reforms in marketing system for export crops	+/-	Increased incentives to plant new coffee and cocoa trees and restore existing plantations at expense of food crops, environmental risks of increased profitability of cotton
Rural credit reform	-	Farmers hampered by collapse of credit in purchase of cash inputs (e.g. labour, fertilizer)
Devaluation of exchange rate	+/-	Planting new areas to export crops, restoring existing plantations
Redundancies and salary cuts in public service and parastatals	-	Widespread impoverishment and environmental encroachment by new and under-resourced farmers
Less public spending on health and education	-	Increased impoverishment due to reduced productive ability; decline in environmental education
Côte d'Ivoire:		
Increase in producer prices, removal of export taxes and liberalized markets for export crops	x	Not fully implemented, but little impact as price reforms swamped by declining international prices
Cuts in subsidies for imported inputs	x	Uncertain impact due to mixed record of reform
Public expenditure cuts	+	Reduced infrastructure development, with the effect of reducing incentives for frontier expansion
'Simulated' devaluation and other trade reforms	x	Largely ineffective, with little or no net effect on exports and the environment
Mali:		
Devaluation of exchange rate	+/-	Boost to cotton and rice, increased pressure for extensification; increased export of livestock, relieving pressure on pasture in short term
Liberalization of cereals market	+/-	Depressed prices, especially of maize
Reform of Office du Niger (rice)	+	Greater responsibility of farmers for irrigation operation and management, including drainage
Abolition of input and credit subsidies	+/-	Increased costs of purchased inputs and discouragement of intensification
Liberalization of farm input supply	+/-	Encouragement of fodder production, with mixed environmental effects; lower quality of inputs

Source: Reed 1992 and 1996
Legend: (+) positive effect on NRM; (-) negative effect on NRM; (x) neutral or no effect on NRM

4.42 Since the removal of subsidies and higher border prices for imported inputs conspired to reduce their use, the main production response was found to be extensification, rather than intensification, especially in Cameroon. Some increase in the use of organic fertilizers was noted but supplies were inadequate to offset the declining affordability of inorganics. Reductions in pesticide use can be viewed as positive for NRM. However, less access to agrochemicals hit smallholders disproportionately, as they could not take full advantage of improving incentives for cash crops because of nutritional needs, limited capital and other constraints (see Chapter 2). Instead, it was primarily the wealthier landowners who could respond to improving relative prices for export crops. As a result, many smallholders reverted to extensification into forests and

marginal lands or reduced fallow periods to make up for lost production, as imported machinery, agrochemicals and seeds were now priced beyond their reach.

4.43 Monetary policy reforms were largely ineffective but cuts in public expenditures were substantive in some countries, comprising the larger part of the implemented portion of Côte d'Ivoire's SAP. In Cameroon, extension services such as technical advice, credit facilities and the provision of inputs were heavily cut, leading to the abandonment of some cocoa plantations and falling smallholder output. In Mali, cuts were accompanied by decentralization of some resource management responsibilities, with savings to government and notably positive results for NRM. Downsizing and dismantling of Mali's state marketing agencies could be expected to have positive impacts in the longer run but created some disruption and uncertainty amongst producers in the interim, with the sorts of NRM responses to uncertainty discussed in Chapter 2. Adjustment aggravated migration in Cameroon and Mali, mostly from urban to rural areas in the former, and the reverse in the latter. Government layoffs in Cameroon, and shrinking employment in the formal sector generally, added to land pressure and poverty-degradation problems in rural areas (see quote earlier). In general, the case studies recognized that price policies could have benefits but that additional complementary policy and institutional reforms were needed to avoid social and environmental impacts.

C. GLOBAL TRADE LIBERALIZATION, EXTERNAL SHOCKS AND NRM

4.44 In addition to an interest in the effects of structural adjustment on the environment, there are grounds for wider concerns about external trade and related international developments and their incentives effects. We include not just the removal of international trade barriers and a freeing up of global trade in this section, but also external shocks which affect the calculus of decision-making at the producer level. For example, climatic events such as El Niño or droughts, which have affected the Sahelian countries in the 1970s and 1980s, can have dramatic impacts on producer prices and agricultural productivity. Similarly, the countries of West Africa are particularly vulnerable to commodity booms and busts, which represent external shocks and have effects on variable incentives (see Figure 1-4). As we show later with a case study from Botswana, even events affecting other sectors can have spin-off impacts on agricultural pricing and production, with consequences for cropping and grazing choices and, ultimately, for NRM.

4.45 Strictly speaking, the incentives effects described above are not amenable to direct policy manipulation and, therefore, of perhaps less interest for this study. However, governments must contend with these external developments and may be called upon to at least react to them, perhaps by adopting mitigating measures. In addition, we have seen above how international price movements can foil well-intentioned structural adjustment efforts. In all of these cases, there will almost certainly be incentives implications for NRM, even if these are ambiguous and difficult to describe in general terms.

Global Trade Liberalization and the Environment

4.46 Global trade liberalization has been a much-discussed topic of late, partly because of the emergence of trade blocks in North America and a hoped-for single market in Europe, as well as the GATT Uruguay Round of Multilateral Negotiations and the setting up of the World Trade Organization (WTO). However, opinions on the merits of trade liberalization are mixed, with many environmentalists opposed to it (Anderson and Strutt 1996, Lutz 1992). A number of researchers have considered the effects of agricultural trade liberalization on welfare in regions

such as Sub-Saharan Africa, in an attempt to clarify its effects (see Lutz 1992, and May and Bonilla 1997, for Latin America).

4.47 Our main interest is in the effects that liberalization would have on world food prices and production incentives. Anderson and Tyers (1991) provide an interesting analysis comparing the current trade situation to one where all barriers to agricultural trade are removed, and thus portrays the international agricultural trade situation under a regime of no distortions. While they point out that an adjustment to such a trade-distortion free situation would take several decades, they argue their analysis gives an idea of how current distortions in the international trading system affect the production and export of food commodities. They consider two scenarios, one in which only developed countries liberalize and another where developing countries do as well. Table 4-6 presents their results for the change in welfare, i.e. net economic benefits, and in the production of key agricultural tradables.

Table 4-6 Effects on Net Economic Welfare and Food Production in Sub-Saharan Africa of Agricultural Trade Liberalization, 1990

	Liberalization in DC's Only		Liberalization in DC's/LDC's	
	Value	**% change**	**Value**	**% change**
Change in Annual Net Economic Welfare (US$ 1985)	1.9		2.2	
Change in Production ('000 t):				
- grains	880	1	5900	9
- beef and sheep meat	680	17	1930	47
- sugar	120	2	2970	42

Source: Anderson and Blackhurst (1992)

4.48 The analysis indicates that by liberalizing as well, African (and other developing) countries greatly improve the benefits they obtain from trade reform. The strong responses overall reflect the high degree of protection and distortion in developed country agriculture, and the high level of discrimination against agricultural production in developing countries under the current trade regime. Under a reformed trade system, agricultural production 'shifts' to the relatively lower cost regions like Africa, particularly when these regions remove the various exchange rate and non-food price distortions in place in 1990.[1] By liberalizing as well, developing countries facilitate the shift and encourage a stronger production response. Trade liberalization would increase livestock production most significantly, while grain production is much less affected. Specific benefits for Africa are liable to be somewhat muted because of the preferential access to Western markets currently enjoyed, as we have already described.

4.49 Driving the impacts on NRM from liberalization are changes in world prices for key food commodities. On a weighted basis (by share of world trade), these would rise by 26% in Anderson and Tyers model if only developed countries reform, but decline by 1% if developing countries liberalize as well. For example, beef and sheep meat prices would rise by 48% in the former case and by 6% in the latter, providing a strong stimulus to increased livestock-based land

[1] Interestingly, the net effect on world agricultural is relatively small, only a 2-4% increase in production overall. The main impact instead is the shift in agricultural production from developed countries to developing ones, ie. from high-input intensive agriculture to low-input extensive agriculture, with positive consequences for environmental degradation arising from reduced 'modern' input use on a global level (Anderson and Blackhurst 1992).

uses. Grain prices are much less responsive, rising 5 to 23% in the first instance (reform in DC's alone) and remaining unchanged or falling in the second (DC's and LDC's).

4.50 Goldin and Knudsen (1990) review other empirical studies that address trade-liberalizing effects on international prices, either when the industrial countries (e.g. OECD) undertake reform alone or in tandem with the developing countries. The authors further distinguish between partial equilibrium and general equilibrium studies. Without developing country reform, price responses are again positive for most commodities, except wheat and feedgrains in some models. More unclear are the likely changes in international prices if the developing countries join in the reforms, although by enabling a freer production response there should be a more "muted" price effect, as is evident in Table 4-7 (Young and Burton 1992).

Table 4-7 Effects of Trade Liberalization by the OECD (and Developing Countries) as Indicated by the Percentage Change in International Commodity Prices

Models	Commodities: Wheat	Coarse Grains	Meat	Dairy	Sugar
Partial Equilibrium Models:					
- Zietz and Valdes	3 (-12)	-3 (-24)	10 (13)	-	15 (1)
- OECD/MTM	-5 (-7)	-10 (-12)	5 (-4)	31 (29)	9 (7)
- USDA/SWOPSIM (1986 base)	27 (23)	16-22 (8-19)	16 (7)	84 (79)	29 (7)
General Equilibrium Models:					
- IIASA (projected 2000)	18 (23)	11 (13)	17 (11)	31 (34)	-
- RUNS	15	8	18	-	57
- WALRAS	17	-	10	14	-

Source: Goldin and Knudsen 1990, cited in Young and Burton 1992
Notes: percent change in international prices with liberalization in OECD only is shown outside brackets; percent change with liberalization in developing countries as well is shown in brackets where available.

4.51 Overall, NRM consequences for Africa from trade liberalization emerging from the theoretical studies cited above and policy-oriented studies discussed in Box 4-6, are somewhat ambiguous. By improving the terms of trade for agriculture, incentives are created to shift economic resources into this sector (Lutz 1992). Instances of individual commodity impacts can be derived from earlier discussions of the responsiveness of producers to price changes, in terms of intensification and extensification, and thus are not repeated here.[1] However, because international prices changes occur at 'arms-length' from the producer, the extent to which countries pass the price changes onto producers will critically determine incentives at this level. Whether liberalization stabilizes world market and prices is a separate matter but one of importance (see above). Furthermore, price effects may stimulate research and other induced technical changes which could produce additional dampening effects on prices, as we discuss in Chapters 2 and 5 (Young and Burton 1992).

4.52 Lutz (1992) argues the most pronounced effects would occur with commercial agricultural, resulting: "in more intensive resource use and the associated negative environmental effects of that subsector" (p. 85), but this could attract more labour into this sub-sector and thereby reduce pressure on marginal lands in some cases. As argued in the previous section, Lutz also sees price stability as having a dampening effect on private discount rates, with potential benefits for investment in land improvements (see Chapter 2). However, he sees these latter

[1] For example, the Uruguay Round's Agreement on Textiles and Clothing is likely to encourage expanded production of cotton, with possible negative consequences for NRM (Paggi 1997).

positive effects on NRM as relatively minor and likely to be dominated by the negative ones cited previously. The simulation modelling conducted by Coxhead and Jayasuriya (1995), reported in Box 4-2, contradicts this conclusion and supports a more positive view of the impacts of liberalization on upland areas.

Box 4-6 Policy Analyses of International Trade Developments and Africa

In a series of more directed studies, FAO examined the practical implications for Sub-Saharan Africa of proposed trade developments under consideration by the global trading community and various trading blocks; these include the proposed GATT provisions under the Uruguay Round (tariff/non-tariff reductions, subsidy restrictions/removals, special treatment for developing countries, etc.); reforms to the EC's Common Agriculture Policy (CAP), expansion of the EC and the imposition of a Single Market; growth of regional trade blocks; and economic changes in the transitional economies of Eastern Europe. These developments can be considered as external, trade-related shocks imposed on African economies with consequences for NRM, although in some cases, such as the Uruguay Round, the impacts may be relatively minor (Paggi 1997). Saran (1993) summarizes the results of the studies, noting that international food prices should rise, especially for beef and sugar, and to a lesser extent for wheat and rice (see NRM impacts referred to above). More recent analysis of the 1994 Uruguay Round also cites price increases (Martin and Winters 1996). Moreover, there could be an accompanying reduction in price volatility, especially in countries which are consistent 'food importers', as suggested by other studies as well (Lutz 1992).[1] In Chapter 3, we discussed the role of 'price risk' as a negative influence on farmers' willingness to invest in land improvements; thus, reductions in international price volatility could have potential incentives benefits for NRM in this respect.

However, there could be important negative effects on Africa from external trade developments. For example, the preferential access to the EC now enjoyed may be lost if third party countries benefit substantially from across-the-board tariff reductions. Similarly, expansion of the EC and the imposition of the Single Market may shift market supply away from traditional sources such as Africa towards Europe itself. Finally, the FAO studies point out that price stability may not have much impact on smallholders, since they are remote from major marketing channels and therefore sheltered from fluctuating international prices (see above); instead, it is argued that most price volatility in Africa is actually domestic in origin (Saran 1993). Further discussion of the potential impacts on agriculture and the environment in the developing countries from the Uruguay Round may be found in Martin and Winters (1996).

External Shocks and NRM

4.53 West Africa is particularly prone to external shocks because of its high dependency on internationally-traded commodity exports, an unpredictable and sometimes harsh climate and its fragile natural resource base. Because of the sizeable debt burden of most West African countries, movements in international interest rates can also have a bearing on domestic economic conditions and, consequently, for NRM. A World Bank study assessed the impact of external shocks on countries under adjustment versus those not adjusting during the period 1981-86, taking into account both terms of trade (e.g. commodity prices) and international interest rate movements (World Bank 1988). The study shows that the impact of these shocks on GDP levels over the period was significant, with countries initiating adjustment prior to 1985 tending to have been harder hit. For this group, the losses averaged 4.6% of GDP in low-income countries and 5.2% in middle-income countries, with terms of trade shocks accounting for most of the losses. In non-adjusting countries, the losses arising from external shocks averaged 3.9% of GDP in low-income and 1.4% in middle-income countries. Terms of trade effects were much less pronounced in the middle-income countries of the non-adjusting group.

[1] This condition certainly covers most West African nations (except the Gambi and Guinea-Bissau), whose cereal imports in 1990 ranged from 36,000 t to 532,000 t (Cleaver and Schreiber 1994).

4.54 Terms of trade shocks chiefly originate from fluctuations in international commodity prices. Figures 4-3 and 4-4 show historical price movements for export commodities of particular interest to West Africa, distinguished in terms of the dryer Sudano-Sahelian Zone, i.e. cotton, groundnuts and hides, and the more humid Forest Zone, i.e. cocoa, coffee and palm oil. All prices are expressed in real terms and are shown as index values (1965=100). Sudano-Sahelian exports were clearly influenced by broader commodity price movements at the international level led by the oil crises of 1973-74 and 1979-80, the relevant real export prices varying by factors of up to two or three over the period. Fluctuations affecting Forest Zone commodities are even more pronounced, with variations of up to 500%, although cocoa and coffee show only a single peak in the mid to late 1970s. Interestingly, the presence of both zones within a single country (e.g. Nigeria) would have produced offsetting effects on foreign exchange earnings during the 1970s, since price peaks occur in different years.

4.55 The extent to which these sharp price movements were passed on to farmers is not clear, since marketing organizations were in place in many countries at the time (see Table 3-1). Nonetheless, where this volatility was experienced by farmers, the impacts for NRM would be as discussed earlier with respect to 'price risk', as well as more general responses to relative prices (see Chapter 3). Exacerbating the effects of the general price decline after 1980 was the presence of drought in West Africa in 1983-84. Droughts represent an additional external shock with implications for cropping returns and household decision-making about NRM use, as we have discussed in previous sections. It has particular ramifications for the pastoral sector, as illustrated graphically in Figure 1-2 and discussed in Chapter 2 (Toulmin 1996).

4.56 Longer-term effects of external shocks, which depend upon how countries react to booms and busts or transient versus permanent income changes, have also been studied. The Dutch Disease refers to a permanent decline in tradables production outside of the 'boom' industry, since the latter pushes up wages, thereby reducing the country's international competitiveness. The non-tradable sector may also be affected, but the direction this takes depends on whether the sucking of labour out of this sector dominates or is dominated by the spending effects stemming from new found wealth in the boom industry (Diakosavvas and Kirkpatrick 1990). Shuh and Archibald (1996) also argue that, in Africa, similar effects have been induced by large aid flows, which can unfavourably drive up exchange rates.

4.57 More recent thinking revolves around the concept of *construction boom theory* (CBT), which adapts the above reasoning to the transient-income opportunities available from commodity booms for small, controlled, open economies, such as those of Sub-Saharan Africa (Brownbridge and Harrigan 1996). The petroleum boom experienced by Nigeria during the 1970s represents a good example of this situation. Unfortunately, most African countries have not benefited much from these often transient income opportunities, and have ended up with massive macroeconomic imbalances once the boom has turned to bust, particularly as a result of large public sector expenditure increases which can no longer be sustained. For a detailed discussion of this topic, see Brownbridge and Harrigan (1996).

4.58 NRM can be affected in many ways by construction booms, but these effects will depend critically on whether the sector involved is agriculture or some other. In the former case, the short-term effects will follow the discussion presented at various stages pertaining to relative price changes. If the commodity is not agricultural, then resources may shift out of agriculture and wages may rise, forcing landowners to consider cropping systems of lower labour-intensity or

perhaps the planting of trees in lieu of annual crops.[1] The implications for NRM cannot be predicted with certainty, as the ultimate effects may extend beyond immediate land use changes. Because of the large number of macroeconomic variables liable to be involved in determining final outcomes, the use of computable general equilibrium models is called for in assessing the changes (see earlier description of these). Box 4-7 provides a description of a CGE modelling exercise in Botswana intended to capture the response to an external price shock, such as we have discussed above. However, in this case the shock originates outside the agricultural sector, in the mining industry, but because of the complex feedbacks at work, changes in natural resource use occur within the livestock-grazing sub-sector, in this case it is worsening rangeland degradation.

Box 4-7 Government Policies, External Shocks and the Environment in Botswana: A CGE Analysis

Botswana has a small, open economy that is particularly dependent on the mining sector (i.e. diamonds). Livestock is the most important agricultural sub-sector in Botswana and overgrazing is common. While policies directly aimed at the livestock sector can have an impact on incentives to hold cattle and subsequently on NRM, it has been recognized that influences operating outside the agricultural sector may be important too. Unemo (1994) has modelled these effects using a computable general equilibrium model (CGE) of the Botswana economy. By taking account of the interrelationships between different sectors of the economy, the author is able to demonstrate how various government policies and external shocks may affect the livestock-stocking rate. The most interesting result is that a 5% decline in the price of diamonds leads to a 12% decrease in the stocking rate, where the latter is measured as numbers of hectares per animal. The main mechanism operating here is the effect of reduced incomes from the mining sector on manufacturing demand and consequently on the cost of capital. As the latter falls, the incentives to invest in livestock improve, and so the stocking rate changes and rangeland degradation worsens. Other policies tested for their impact on stocking rates include a deterioration in the terms of trade, elimination of certain import tariffs, a sudden inflow of foreign currency and increasing opportunities for labour abroad (migration).

Source: Unemo (1994)

[1] This effect was noted in Karnataka, India, where a booming Bangalore-based high technology industry has raised urban wages and drawn labour from the rural areas. One response has been the planting of *Eucalyptus* under social forestry programmes on wealthier farmers' lands in response to the changing incentives for annual cropping vis-a-vis private forestry which requires much less labour input (FAO/IC 1992b).

Figure 4-3 International Prices Relevant to the Sudano Sahelian Zone, West Africa Cotton, Groundnuts and Hides, 1965-94 (Real Price Index, 1965 = 100)

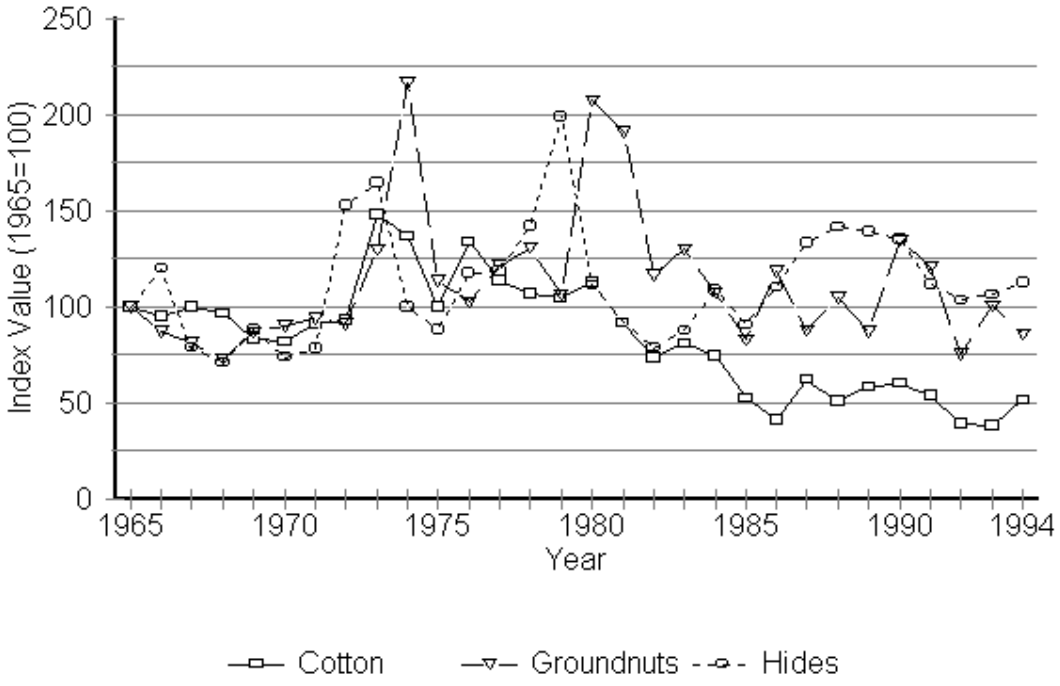
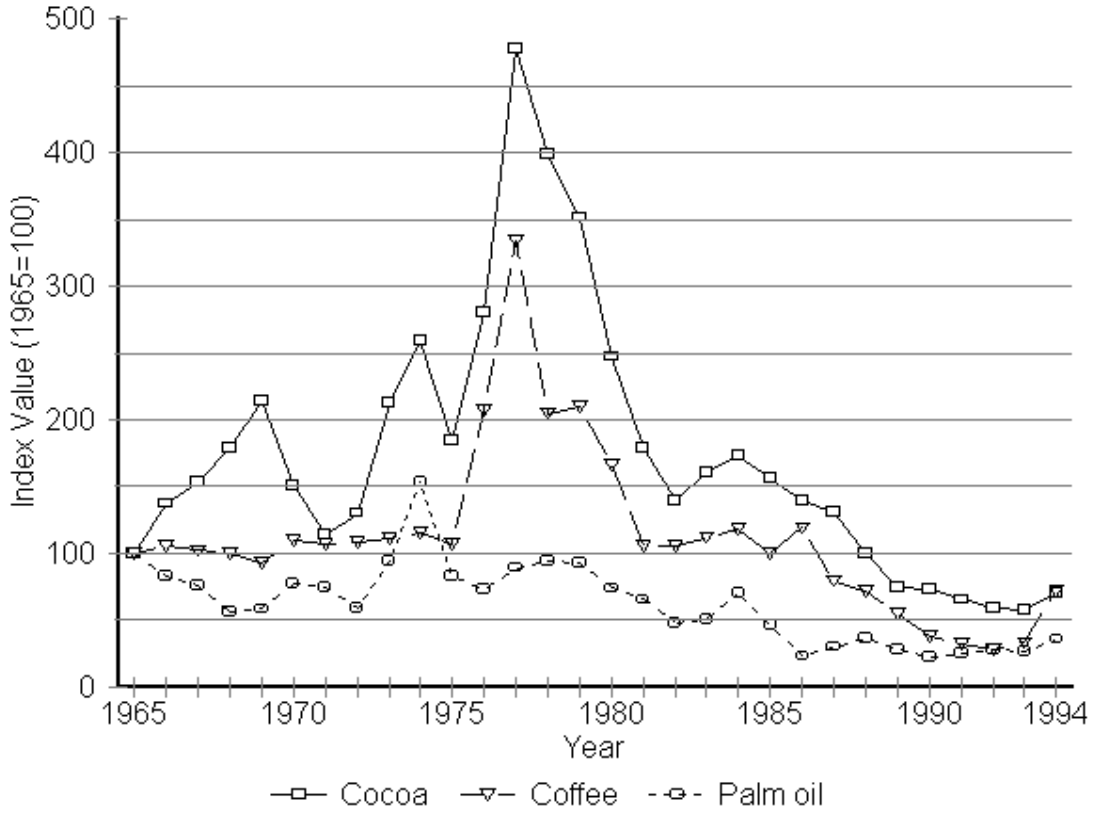


Figure 4-4 International Prices Relevant to the Forest (Humid) Zone, West Africa Cocoa, Coffee and Palm Oil, 1965-94 (Real Price Index, 1965 = 100)

Source: IMF International Financial Statistics Yearbooks

Notes: Price bases are: cocoa beans, New York and London price; coffee, Uganda (New York) price; palm oil, Malaysia (N.W. Europe) price; all series deflated with the Industrial Country



Consumer Price Index

5. USER ENABLING INCENTIVES AND NRM

5.1 Households make land-use decisions based on the technological and resource endowments available to them, their social and economic characteristics, tenurial security over their land and the availability of potentially constraining, variable factors of production (see Figure 1-4). This chapter focuses on elements that affect the producer's decision-making behaviour through social and institutional arrangements governing natural resource use, such as land tenure and traditional resource management systems (see Appendix to Chapter 5). In addition, we consider government and other agency support services indirectly affecting NRM through their influence on producer behaviour. Regarding the latter, we focus specifically on the availability of non-commercial credit and the provision of information to producers, via research, extension and farm support programmes. In the taxonomy of indirect incentives discussed in Chapter 1, we are concerned with the *enabling environment* and the incentives created for households regarding improved land management.

5.2 Institutions can represent many different things, and, therefore, further clarification of what is meant by this term is warranted. Van Arkadie (1990) provides a useful discussion of the role of institutions in agricultural development and makes a clear distinction between two different uses of the concept. He refers to institutions as the rules of society which set the conditions within which all market activity takes place. He distinguishes this use of the term from the notion of organizations who are instead actors operating outside the normal market sphere, such as government agencies, donors, NGOs, etc. We will try to maintain the same distinction, grouping land tenure and other NRM institutions together and separate from services provided by governments and donors that have a bearing on incentives for NRM.[1]

A. INSTITUTIONS AND INCENTIVES FOR NRM

5.3 Institutions which guide natural resource use, both at a formal and informal level, play an important role in NRM, since they influence decisions at the household level which can dictate agricultural or pastoral practices. The link between land tenure and these other institutions represents an important example, as discussed in the accompanying Appendix to Chapter 5. Formal institutions are established in law and include those elements of national constitutions and legislation dealing with land ownership/use, property rights in land, animals or trade (Swift 1994). In contrast, informal institutions and organizations are those without comprehensive formal recognition by the modern state -- the habitual ways not established in natural law by which a society manages its affairs, such as customary land tenure rules and procedures to resolve conflict over access to resources. NRM responsibilities may be abrogated, as when formal institutions do not enforce regulations over resource use, or they may erode, as traditional NRM institutions degenerate under pressure (Berkes 1989). Often the institutions in question are concerned with commonly used lands, but not always. Where no institutional regime governs NRM, then a situation of *open access* may be said to exist (see Box A5-1).

[1] Alternative definitions are certainly possible. For example, Pretty (1995) follows Norman Uphoff in referring to institutions as a persistent sets of norms or behaviours and organizations as "a structure of recognized and accepted roles" (p. 135). Under this taxonomy, organizations are a subset of the broader grouping of institutions. Thus, local governments and banks are organizations but also institutions, while the legal code and indigenous management systems are institutions only.

5.4 The following sections consider three options for addressing individually -- farmed or commonly -- used lands subject to deteriorating or non-existent institutional controls. First, we consider the effects of modifying land tenure on the incentives to invest in land improvements. Appendix 5 provides background on the controversy surrounding the privatization of land tenure to accompany the main text. Second, we consider the incentives effects of state intervention in institutional arrangements, through *nationalization, sedentarization* or *collectivization* policies, all of which can be disruptive of local level NRM institutions. *Decentralization* is also considered, as it is one means by which governments may shift NRM responsibilities from the formal level to a more informal one. Third, we look at the incentives for collective action to conserve and manage common property resources. This problem involves an important class of resources or NRM-related activities of interest to rural households, including shared farm or pastoral management systems, water resource allocation (irrigation), pest control and systems governing the harvesting of various products from common and private lands.

Land Tenure, Privatization and NRM

5.5 The effect of land tenure security on investment demand, credit supply and productivity has been investigated in a number of studies. The most thoroughly investigated theme is the effect that government provision of land titles or *privatization* will have on land-related investment decisions. Figure 5-1 outlines some of the hypothesized linkages between land tenure security (including secure user rights and land transfer rights) and investment demand. It suggests that by providing more security to the farmer and by providing collateral to the lender, tenure security results in increased investment, more demand for inputs and subsequently increased output levels and higher land value. From an NRM perspective, this line of reasoning is particularly applicable to investment in structures for soil and water conservation, since these are more likely to involve out-of-pocket costs. In contrast, changes in farming practices consistent with the land husbandry view of sustainable agriculture (see Chapter 1) require greater inputs of information and, therefore, may depend more on research and extension services. The latter are discussed later in this chapter.

5.6 Despite the clearly delineated relationships of Figure 5-1, the linkage between tenurial security and investment in sustainable cropping practices is not always clear. Although tenure reform, by improving individual ownership security, may be expected to increase agricultural investment and improve productivity (see Feder *et al* 1988), it is also possible that such investments are not ecologically sound or they would not take place in any event, due to the inappropriateness of the tenure reform or because various economic factors provide perverse incentives for good NRM.

5.7 In a simple model of title, tenure security and productivity, Carter *et al* (1991) show that an investment will be undertaken by a producer if its expected present net value is positive. They define the net present value to include a term which measures the probability of the farmer being evicted from a field, as determined by the field's tenure status. Hence, if the perceived probability of eviction increases, the implied shift in tenure security would result in decreased investment. They argue that if this model is representative of reality, then the empirical evidence should show that more securely titled landholders would make greater investments in land, resulting in superior agricultural performance and higher net returns. However, the authors find no empirical evidence to support this hypothesis. A description of the theoretical model is provided in Box 5-1.

Box 5-1 A Model of Title, Tenure Security and Productivity

Consider the following simple present value model of net returns to investment in agriculture:

$$E(PV_{ik}) = \sum_{t} \frac{[(1-f_{kt}(T_k))p_{ikt}(\overline{M})]}{[1+r(\overline{T},\overline{M})]^{t}}$$

where *I* is the investment project made on field *k*. The expected present value is the weighted, discounted sum of the yearly net income, p_{ikt}, generated by the investment in each year *t* of its duration. In addition, f_{kt} is the probability that the farmer will be evicted from field *k* in year *t* and is a function of the tenure status, T_k, of that field. The model assumes that reduced legal exposure to eviction implies a perception of a lower probability of eviction on the part of the producer.

As is shown by the equation above, annual net income is weighted by the probability $[1-f_{kt}]$, that the farmer will actually realize the returns from investment on field *k*. The term $r(\overline{T},\overline{M})$ 0is the farmer's discount rate, assumed here to be the shadow price of capital on the farm. The variables *M* and *T* are farm level variables that measure market access and aggregate tenure status respectively. *T* is a weighted average of all the T_k `s which describe the different fields comprising the farm. Investment *ik* is therefore assumed to be undertaken if:

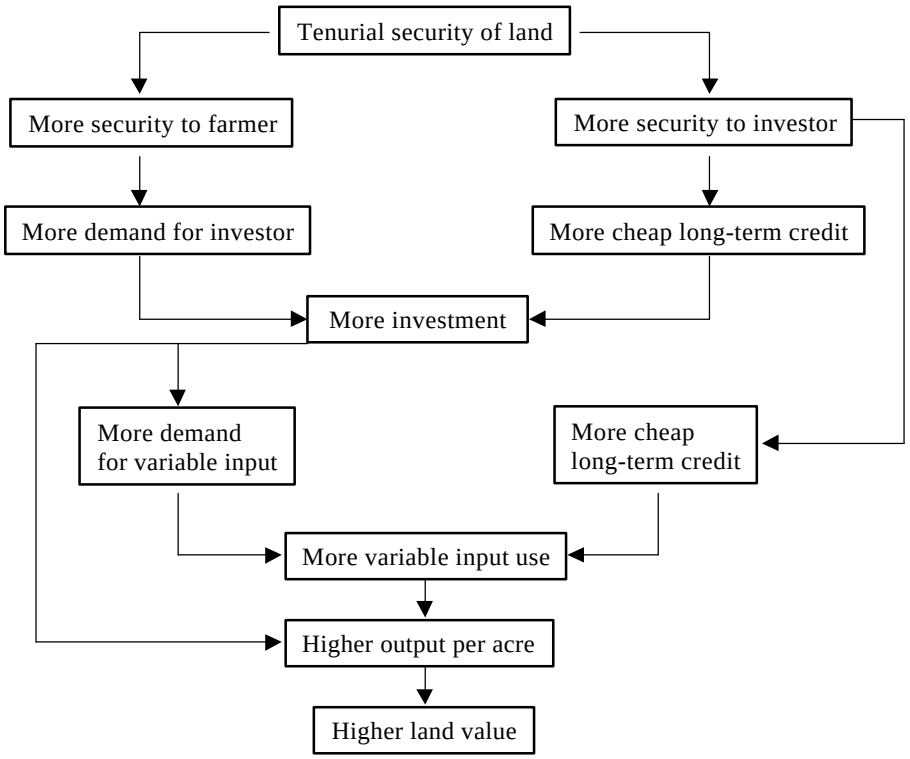
$$E(PV_{ik}) = C_i^*$$

where C_i measures the immediate direct costs of the project. Hence, holding the farm's discount rate and market access as fixed, the number of investment projects undertaken can be expressed as a function of the eviction probability. As the eviction probability decreases, the expected present value of a given net income stream increases and more investment projects become worthwhile.

Source: Carter *et al* 1991

5.8 In contrast, Sjaastad and Bromley (1997) show that the effect of land security can be ambiguous. They develop a model which shows that indigenous land tenure may provide equal or higher investment incentives than private rights, and may promote modes of rights appropriation that are productive rather than wasteful. They also build into their model the assumption that investing in land may increase security of tenure. Thus, insecurity of tenure may be a disincentive to invest, but there may be an incentive aspect in that investment itself will increase security. Although more investment in land, or perceived investment in land, may lead to securer user rights, a perverse incentive effect is also possible if land is cleared or ploughed and then left, resulting in land degradation but increased tenure security. Thus, not only can land rights and tenure security be affected by producer behaviour and in turn affect producer behaviour, but the effects on NRM may be ambiguous.

Figure 5-1
Linkages Between Tenure Security and Investment Demand



Source: Pearce, Barbier and Markandya (1988)

5.9 The authors conclude from their theoretical model that:

- as the discount rate increases, the likelihood of indigenous tenure providing the higher investment incentive (compared to private land) increases;
- as the production benefits of an investment become smaller relative to land rent, the likelihood of indigenous tenure providing the higher investment incentive increases;
- as the initial probability of eviction decreases, the likelihood of indigenous tenure providing the higher incentive to invest increases; and,
- if the probability of recovering the investment even when evicted is higher, a very small decrease in eviction probability is required to render the investment incentive higher under indigenous tenure.

5.10 Hence, it is possible that investment will be undertaken under indigenous tenure conditions even when no production benefits result from the investment.

5.11 Several empirical studies critical of the property rights theory are reviewed in Place and Hazell (1993). They show that, in Rwanda and Ghana, an increase in individualized land rights does not appear to have had any effect on agricultural investment and yields, whereas in Kenya there is a slight, although insignificant, relationship between these variables (Pinckney and Kimuyu 1994, Migot-Adholla *et al* 1981). In terms of the relationship between the status of land rights and long term land improvements, these studies found mixed results with no clear trends confirming the relationship between investments and land use rights or transfer rights (see Table 5-1). In a separate study concerned with Rwanda, Blarel (1993) finds that improvements are strongly related to tenure. Moreover, Besley (1995) finds that in Wassa (Ghana) better land rights facilitate investment, in this case tree planting, although in a second area, Anloga, there appears to be no significant relationship between land rights and investment. These latter studies appear to conflict somewhat with the results reported by Place and Hazell in Table 5-1.

Table 5-1 Long-Term Land Improvements and Land Rights in Three African Countries

Land Rights	Rwanda			Ghana			Kenya	
	Butare	**Ruhengari**	**Gitarama**	**Anloga**	**Wassa**	**Ejura**	**Madzu**	**Kianjogu**
Not transferable (limited transfer)	-	-	-	-	-	-	-	-
Transferable but not sold (preferential transfer)	live hedges trenching grass strips destumping tree planting	-	live hedges trenching grass strips destumping tree planting	-	-	-	-	drainage or liming
Land sold (complete rights)	live hedges trenching grass strips destumping tree planting	-	live hedges trenching grass strips destumping tree planting	drainage and land excavation	planting of tree crops not related to LR	-	planting of tree crops, terracing	-
Long term use rights	-	-	-	-	-	-	-	-
Short term use rights	-	-	-	-	-	-	-	-

Source: Place and Hazell, 1993

5.12 There is further evidence from Africa that the role of tenurial security and well-defined land rights is neither obvious nor conclusive. Matlon (1993) studies the situation in Burkina Faso where tenure security is considered high, and compares the extent of soil fertility management with types of tenure. He concludes that there is no evidence that better tenure security leads to greater use of manure and fertilizer. However, a similar study in Uganda finds that land registration is significant and positively related to investments in fencing, manuring and mulching and positively, though insignificantly, related to longer-term investments (Roth *et al* 1994). This finding is also supported by Hopkins *et al* (1995), who survey households in Niger and conclude that security of tenure has an impact on some investment decisions, particularly those of a short term nature. Hopkins *et al* (1995) make the notable point that securely tenured land tends to be cultivated longer than insecure land, but the reasons for this remain unclear.

5.13 Doolette and Magrath (1990) survey tenure systems in Asia, in the context of watershed conservation, and conclude that the data on the impact of tenure on investment and adoption of new technologies is ambiguous here as well. They note that the farmer's sense of long-term tenurial security will affect his willingness to invest in land improvements but that lack of tenure security is more important when customary rights are not strong and where farmers without title may be evicted. In contrast, Chalamwong and Feder (1987) use the price of agricultural land as a proxy for land productivity in Thailand to analyze the relationship between ownership security and farm productivity. They find that legal titles to land are a significant factor in explaining variations in land prices. This and other related studies by the same authors show that the difference in land values is mainly due to the credit advantage accruing to owners of documented land, a topic we pick up again in Section 5.2.1 (Feder 1987, Feder and Onchan 1987). The general conclusions of these studies are that:

- the lack of legal title to land reduces its value as collateral, thus increasing the price of capital and reducing the value of investments in land improvements;
- high transactions costs associated with establishing ownership will reduce the value of investing in land improvements; and,
- the absence of a land market will reduce the value of such investments to the farmer and prevent efficient gains from trade.

5.14 In general, these studies suggest that land rights may or may not be a significant factor in determining whether farmers make land-improving investments on croplands. In Kenya, while many farmers are eligible for land titles, they do not bother to update them. This relaxed attitude to land titles in Kenya, and the variation in land claims, suggests that customary tenure systems still exert strong influence on investment decisions. In addition, Cartel *et al* (1991) point out that the effects of land tenure may be obscured by other factors, such as the size of land holdings and the failure of smaller farmers to gain access to labour and credit markets. Another binding constraint might include inadequate access to improved technologies.[1]

5.15 Privatization of rangelands similarly may provide uncertain benefits. Kenyan experience demonstrates that pastoralists employing traditional opportunistic management strategies may actually be improving rangelands in South Turkana, by enhancing the recruitment reliability of *Acacia tortillis*, an important browse and fuelwood tree species. Other studies suggest that this is not an isolated phenomenon (Walker and Noy-Meir 1982, Blackmore *et al* 1990). Further

[1] Some of the discussion in this section is based on a review of the literature presented in ODA/FSG (1996) and the reader is directed to this document for additional discussion of this topic and more detailed references.

empirical evidence against the property rights theory in a pastoral context comes from Botswana and China. In these countries, policy makers have sought to promote the coexistence of private and common property rights (see Box 5-2). In Botswana, privatization has encouraged private landowners to graze their stock on the communal lands while their private rangelands are allowed to regenerate. This action restricts the access of herders' stock to the communal lands and has led to overgrazing. In the province of Qinghai in China, attempts to privatize range resources has suffered from incomplete coverage, allowing the remaining unprivatized common lands to be overgrazed as open access resources. Meanwhile, income disparities prevent poorer herders from asserting their property rights over their allocated winter grazing lands, since they cannot afford to fence them.

Box 5-2 Problems with Privatization of Rangeland Resources in Two Countries

The Government of **Botswana** introduced 'The Tribal Grazing Land Policy' ranches combined with borehole drilling technologies in the late 1970s to improve range productivity, enabling large land managers to monopolize water and grazing resources. The policy failed to reduce stock numbers in line with 'carrying capacity' targets or improve returns on investment. Further, under the new national policy for agricultural development it is proposed that communal lands should be fenced and turned over as de facto private property to wealthier cattle owners, with the aim of reducing the carrying capacity of the land and consequent land degradation. The policy will deprive 60,000 people – many comprising the poorest fraction of the population -- of their livelihoods who depend on cattleposts. The privatization of the range has had disastrous consequences for communal lands since private owners use the traditional lands while allowing private lands to regenerate; herders have to rely solely on the communal areas. Abel and Blaikie (1990) have argued that a 'tracking' or opportunistic management strategy would allow higher numbers of stock to be kept on the range with the advantage of utilizing surplus feed in wetter years (see Chapter 1). Their work reinforces the argument that highly controlled grazing regimes represent an inefficient strategy for managing the national herd and NRM since they reduce flexibility and prevent opportunistic use of the range during wetter years (Scoones 1994).

In **Qinghai Province (China)**, Tibetan herders live in tents and move between their traditional winter sites and the summer grasslands, relying primarily on yaks, sheep and a few goats for their livelihoods. Rangeland productivity is declining at a rate of at least 0.4% per year, due to overgrazing, and livestock productivity is similarly falling, as seen in high mortalities and severe weight loss over the winter (FAO/IC 1993). A number of management approaches to resolve the dilemma have been considered, including regulating off-take or herd size and privatizing grazing lands. In the latter case, the Chinese government had allocated much of the relatively more scarce winter grazing lands by 1993 and provided a fencing subsidy of about 40% (subsequently removed). The allocation was done on the basis of a variety of measures relating to the repatriation of people and animals after a period of collectivization. In general, land allocation depended on household size, livestock ownership and in some areas was based upon land holdings at the time of collectivization (Hinton 1990). In a few cases, land was allocated to tent groups of 10-15 families (as in the traditional system). Several problems have arisen related to the remaining unallocated areas, which are essentially open access resources, and the inequitable access to fencing due to its cost. Since poorer herders cannot fence, they may find their land encroached, while richer herders can continue to overuse common areas and under-utilize their own land, saving it for the leaner periods of the year. More recent initiatives under a US$ 50 million IFAD-funded project are intended to reduce the uncertainties and risks associated with the herders' production system and ultimately to reduce livestock-related losses. Thus, effort is targeted at altering the so-called 'survival algorithm' discussed in the Appendix to Chapter 2.

5.16 Aside from the growing evidence that the link between land rights and productive investment decisions is at best highly variable, there is evidence that land titling can have more pervasive effects, with negative consequences for NRM. For example, analyses of tenure systems in some African countries also show that privatizing land tenure can promote land grabbing, concentration of ownership, *de facto* expropriation of land or user rights held by women,

landlessness and increasing marginalization (Atwood 1990, Bruce 1993, Cleaver and Schreiber 1994). Earlier chapters have reviewed some of the effects such developments might have on NRM; further discussion of some aspects (e.g. heterogeneity) is presented in the next section (*Incentives for Collective Action and NRM*: para.5.28 to 5.37). Privatization may also extinguish secondary land rights, affecting women and seasonal herders who may depend on these forms of traditional tenure for their livelihoods. In the latter case, conferring land tenure rights on sedentary agriculturalists may disrupt a system of pastoral semi-nomadism, based on rights of passage and dry season grazing, which has constituted a sophisticated response to ecological conditions (Bayer and Bayer-Waters 1994).

5.17 Many farming systems in arid and semi-arid areas, where large fluctuations in rainfall and productivity are common, rely on these complex livestock-cropping interactions, involving the management of forage, manure and draught animals for joint benefits. In these traditional farming systems, mobile herds have provided an important source of nutrients in the form of manure for cropping, while herds are taken away from cropping areas during the wet season, reducing crop damage. An expansion in arable cropping, supported by land titling, or changes in cropping patterns, such as the introduction of cash crops like cotton, can restrict herders' customary access to stubble grazing and increase the conflicts over crop damage between herders and settled cultivators (van Raay 1975). By denying herders access to valuable grazing resources, farmers adopting commercial cash cropping and non-pastoralists investing in cattle for financial reasons may limit the options open to pastoralists and cultivators practising mixed farming systems of a more sustainable nature.[1] Such has been the case for Fulani transhumants in Northern Nigeria, discussed in more detail in the next section (FAO/IC 1990, Reisman 1989). Related points were also made in the Chapter 3 with respect to the transport of livestock to markets and declining access to grazing resources en route.

5.18 In summary, neither agricultural nor pastoral sector studies provide conclusive evidence that privatization has increased investments in land or motivated sustainable practices and, in some instances, it has had the opposite effect on NRM. Privatization may or may not result in sustainable investments in land, and it appears that while it may be accepted by producers because it guarantees land rights, it does not necessarily bring about changes in their natural resource use strategy. In contrast, there are numerous studies indicating that traditional institutions governing access to land resources are flexible in responding to internal and external pressures. In Table 5-2, we summarize the empirical evidence provided by the studies cited in this section. Land tenure types pertaining to agricultural systems are divided into the broad categories of private and customary tenure.

[1] Seabright (1993) shows how such conflicts can actually lead to reduced benefits for both pastoralist and arable farmer. Since herders now graze fields clandestinely, they remove their animals without depositing manure so that agriculturalists lose biomass (eg. stubble) anyways but do not receive the offsetting manuring benefits.

Table 5-2 The Effect of Agricultural and Pastoral Tenure Type and Perceived Tenure Security on Investment Decisions

Tenure Type	Country	Perceived security of user rights	Impact on investment decisions	Study
Private titles (cropping)	Ghana	high	+/x	Besley
	Rwanda/Ghana/Kenya		x	Place & Hazell
	Uganda		+/x	Roth *et al* (1994a)
	Somalia		x	Roth *et al* (1994b)
Customary (cropping)	Zimbabwe	high	+	Harrison
	Rwanda/Ghana/Kenya		+/x	Place and Hazell
	Rwanda		+	Rwanda
	Burkina Faso		x	Matlon
	Niger		+	Hopkins *et al*
Private (pastoral)	Botswana	low	-	n.a.
	Qinghai, China		-	FAO/IC, Hinton

Note: (+) positive effect on investment in improvements; (-) negative effect on investment; (x) neutral or no effect on investment

Incentives and State Intervention in NRM

5.19 The intervention of national governments in NRM, particularly in the pastoral sector, can have varied effects on the incentives for NRM. Contrasting with privatization, the assumption of state ownership of resources represents a form of *centralization* of control, one which national governments are not always able to support properly, given limited resources for the management of vast lands and for the enforcement of formal legal controls. National governments also may have distant and antagonistic relations with local communities, making efficient management of natural resources difficult and instilling disincentives at the local level (Baland and Platteau 1996). Furthermore, national governments may manage state lands for purposes other than wise use or local welfare, instead emphasizing such objectives as rent or revenue extraction or self-serving political ends (Baland and Platteau 1996). On the other hand, decentralized systems of NRM, initiated and supported by national governments can provide appropriate incentives for improved NRM under certain circumstances.

5.20 In Mali, the *nationalization* of grazing resources in the inland delta of the river Niger has had the effect of displacing one of the more sophisticated pastoral tenure systems found in Africa (see Box 5-3). The settlement of pastoralists as a means of improving productivity and land management has also frequently disrupted traditional grazing systems. These programmes have typically had a negative effect on the welfare of pastoralists and adversely affected the environment. Settlement may occur as an overt policy objective, such as *collectivization* in Tanzania or Ethiopia, or as part of a land reform programme. Village titling presents a double-edged sword to pastoralists since there are advantages from having land registered to provide protection from land grabbing, but this poses problems for the pursuit of opportunistic grazing strategies when households are confined to permanent locations. A study of villages in Hanang district in Tanzania illustrates how *sedentarization* has affected cultural practices and land management (see Box 5-3).

Box 5-3 Case Studies of Nationalization and Sedentarization in Pastoral Areas of Africa

Under the customary system in **Mali**'s Inner Delta of the Niger, dry season flood pastures were divided into thirty pasturing territories allocated to sub-clans of Fulani transhumant pastoralists (Moorehead 1989). The movement of stock was carefully regulated to allow all Fulani groups access to the flood pastures as the floodwaters fell each year. Outsiders were only allowed access on payment of a fee. Herd movements were controlled in detail according to an appointed place within a social hierarchy of each clan member. According to the environmental conditions each year clan members responsible for a given territory set the dates on which crossings into the pastures should take place. With the nationalization of pastoral resources, the Livestock Service began to set the dates at which stock were allowed into the area, without reference to pasture conditions pertaining to the drylands each year. An inflexible policy endeavoured to keep animals in the upstream areas of the delta for as long as possible during the dry season with the result that animals moved on to flood pastures when they were dry, so preventing regeneration of the pasture resource. Whereas before a clear system of rules applied to Fulani groups and outsiders using the area, after nationalization the state considered all herders citizens of Mali and at least in theory provided them with equal rights.

Collectivization in **Tanzania** through the Ujamaa programme is an illustration of one of the most concerted attempts in Africa to settle a rural population. The demarcation of village boundaries has had the effect of disrupting customary pastoral land-use patterns since they do not necessarily coincide with ecological land use units used by pastoralists. The new tenure arrangements facilitate 'arbitrary encroachment' and invasion by outside individuals and institutions against the interests of villagers (URT 1992:61). Nearly a quarter of a million pastoralists (Maa and Tatoga speakers like the Barabaig) who rely on communal lands for livestock production now find the best of their lands taken and their movements restricted. In the Barabaig case some 100,000 hectares of prime grazing land was acquired by the Government for a parastatal wheat scheme. Indications are that the scheme has completely undermined the Barabaig's grazing system and has adversely affected the environment and Barabaig welfare (Lane and Scoones 1993, Lane 1991).

5.21 State intervention can be defended in some cases, when viewed as part of transition process that sees communities experiencing a decline in traditional institutions. Such communities may not have had the requisite time to develop new, more effective institutions to contend with the new realities. Instead, communities (or nations) undergoing such transitions may rely on the state to shore up basic rights and NRM systems in the interim. However, Bardhan (1993) points out that "this frequent recourse to external political intervention, however justified in individual cases, has the general effect of making local sanctions much less effective in punishing defectors from cooperative arrangements" (p. 91). Thus, incentives for better NRM may suffer.

5.22 As one response to unsuccessful national institutional arrangements governing NRM, many of the functions performed by formal, often centralized, institutions could be handled by informal authorities (Sylla 1994). This notion of *decentralization* has been broadly defined as:

> " ... the transfer of responsibility for planning, management, and the raising and allocation of resources from the central government and its agencies to field units of central governments ministries or agencies, subordinate units or level of government, semi-autonomous public authorities or corporations, area-wide, regional or functional authorities, or nongovernmental private or voluntary organizations." (Rondinelli and Nellis 1986, p. 5)

5.23 The literature on decentralization is vast and includes a number of definitions. Cohen and Peterson (1996) warn against the careless use of definitions and "naive arguments that bureaucracies should be drastically reduced and power and responsibility for public sector tasks be transferred to local communities, private sector firms, and organizations." At the same time, however, adaptive planning procedures which institutionalize participation are being increasingly adopted by planning bodies (Pretty, 1995). Such strategies include national conservation strategies (NCS), national environment action plans (NEAP) and national sustainable

development strategies (NSDS). These strategies, as noted by Pretty (1995), require planning processes to be more responsive to diverse needs and opportunities. Hence, whereas a call for decentralization may be 'naive' or inappropriate, there is strong support for strengthening the role of institutions which require the public sector to incorporate the capabilities and needs of local communities.

5.24 Rondinelli (1991) lists a number of factors which may affect the success of decentralization efforts related to community water supply, but these have broader relevance and so are generalized below:

- Appropriate incentives must be available for individuals and groups to participate in NRM, and for government agencies to provide assistance to them;
- Appropriate skills and resources for community participation and NRM must be developed or strengthened;
- Appropriate and effective processes must be developed for on-going NRM activities and the process must be institutionalized within the community;
- Cooperative organizational relationships must be developed through which individuals and groups can participate in NRM and government agencies can provide assistance;
- Appropriate and efficient technologies must be available to allow communities to manage their natural resources effectively; and,
- Monitoring, feedback and evaluation systems must be developed or strengthened to ensure effective and efficient community management.

5.25 In Africa, the process of decentralization has sometimes been undermined for a number of reasons. In some cases, the delegation of power to field staff, referred to as *deconcentration* has taken precedence over *devolution* to locally elected leaders, with reduced effectiveness for NRM (Adamolekun 1991). Political systems (e.g. one party states) have also presented problems, as have financial weaknesses at the local government level and inadequate monitoring of expenditures (Adamolekun 1991). Clearly, decentralization cannot work where it is done carelessly by governments wishing to escape responsibilities or where opportunities are created for conflict or local élites to take control (Werlin 1992). Concomitantly, local level institutions cannot operate in isolation from the formal bodies which exert an important influence on informal authorities and on household decision-making. Local institutional capability and strength also appear to be significant factors in dictating how well natural resources are managed at this level under decentralized NRM and how communities govern their resources in relation to outsiders, particularly when faced with potential appropriation.

5.26 Despite these potential qualifications, there are some interesting African examples of the process of decentralization, where authority over resources have been transferred to communities or local user groups. Box 5-4 describes the case of Botswana, where the government handed over to local user groups dams which it had constructed for watering livestock, and Lesotho, where control over the range has been transferred to grazing associations (Swallow and Brokken 1987, Fortmann and Roe 1981). In a recently initiated scheme in Mali, following the transition to democracy, some NRM powers have been transferred to *collectivités*, although there is uncertainty over the extent of sharing of management control (Benjaminsen 1997). This programme is argued to be a useful framework for the further promotion of *Aménagement des terroirs* activities, which cede control over local land management planning to management committees governed by land management plans. In the past, the national statutes imposed a legal

constraint on such programmes by obscuring incentives for long run investment in NRM consistent with the *terroirs* approach (FAO/IC 1992a).

Box 5-4 Decentralization and NRM in Southern Africa

Between 1974 and the early eighties the government of **Botswana** introduced a dam building scheme to water livestock and later handed over some of the dams to local user groups under management agreements which stipulated management guidelines such as payment of dues, maintenance and restrictions on water use. The dams have worked well in part because the resource has been managed collectively and also because the infrastructure was simple and easy to maintain. Management rules were used and applied flexibly (number of users, types and forms of use). However, there have been a number of problems, In Botswana surface water does not belong to anyone and problems occurred due to restricting access. In applying management rules some groups were weak and unable to enforce guidelines. The groups which achieved success were those that demonstrated strong leadership and social cohesion.

Recent range policy in **Lesotho** has emphasized a dual strategy of ensuring greater control of management decisions by grazing associations yet strengthening the institutional capacity for better administrative regulation of grazing by enforcing the role of chiefs in range management. The grazing associations are not traditional management structures, rather they combine traditional customary authority with external support backed up by technicians who assist in enforcing management practices laid down by the associations and the collection of grazing fees from herders. The use of penalties (fines paid by offenders) is a useful tool enabling the associations to enforce the rules set out by the associations.

Source: Swallow and Brokken 1987, Fortmann and Roe 1981

5.27 It is important to achieve the right balance between institutions operating at a local and national level and the sharing of responsibilities must be clear (Sylla 1994). The experiences from dam groups in Botswana and grazing associations in Lesotho provide important examples where local institutions can carry out the bulk of the work. National level institutions continue to play an important part in defining user rights, which is vital in ensuring successful NRM. Local level NGOs have been criticized for failing to consider the broader national and regional context in which they operate and the longer term trends which affect the viability of the projects they initiate (Hogg 1992). With respect to pastoral institutions and NRM, there appears to be a need to harmonize objectives between formal and informal authorities. For example, some projects are designed on the basis of meat production and environmental protection but these issues may not reflect the concerns of herders.

Incentives for Collective Action and NRM

5.28 Intervention in the management of land and other natural resources through land titling or state ownership presupposes that alternative institutional strategies are not viable. However, there is ample evidence that cooperative arrangements, often based on traditional institutions, can work in the management of certain natural resources. As discussed earlier, these are generally natural resources characterized by depletability but where difficulties exist in excluding others from access.[1] In the case of such *common property resources,* there is a divergence in the short run incentives facing the individual and the longer run interests of the individual, local community or nation (Perrings 1996). Although there is a preponderance of discussion of common property land

[1] This class of goods or services, referred to as *common pool resources* by some, can be distinguished from other types, such as *pure public goods*, which are not depletable and also demonstrate difficulties in excluding individuals (eg. national defence); *club* or *toll goods*, which at least up to some point are not depletable but excluding other users is possible (eg. toll roads, golf clubs, etc.); and, of course, *private goods.*

resources, private land use may be overlaid with cooperative arrangements governing various other aspects of farming system management, such as pest control, irrigation, uniformity of farming practices or regional coordination of marketing and distribution (Pretty 1995). Perhaps more importantly, from this study's perspective, land management activities such as contour ploughing, stone lines and other structural works (e.g. terracing) require cooperation amongst several or many farmers to be effective.

5.29 Often there may be a perceived need for collective action. For example, individuals may not be able to undertake resource management activities alone or there may be no point in doing so, as in maintaining one's own immediate access to an otherwise decaying irrigation system or undertaking locust control activities alone (Ostrom 1990). Collective action may significantly reduce the costs of repeated transactions amongst many individuals by establishing a single set of rules and reducing the requirement for individualized negotiation and transaction (Berkes 1989). However, collective action is not automatic, especially when information is lacking on NRM or the underlying physical degradation processes are slow and insidious. Poor information or institutional incentives may appear to inhibit action, and this can result in the under-management of natural resources. Additionally, there may be a threat of 'free-riding' by individuals who may benefit from collective action without contributing, and this may lead to insufficient investment in NRM, as collective incentives would be lacking. Determining the precise nature of institutional incentives in a given setting can require specialized analysis, as demonstrated by the use of systematic institutional analysis in Box 5-5.

Box 5-5 Institutional Analysis and CARE's Majjia Valley Project in Niger

To address a severe wind erosion problem in the 100 km Majjia Valley in southern Niger, CARE and the Nigerian Government embarked on a programme of windbreak development. An analysis of the project looks at its institutional aspects in an attempt to assess their strengths and weaknesses, including the role of incentives (FAO 1992). A systematic form of institutional analysis is used which draws on the concepts of *rights* and *duties* facing the agents involved in use or ownership of the resources in question, as well as the *powers* and *liabilities* associated with the officials concerned. Recognizing the nature of the resources in question is a first step: the windbreaks provide a public good through the protection of croplands, a benefit from which no suitably located farmer can be excluded. However, the windbreaks also provide consumptive goods, in the form of timber/fuelwood, fodder and seeds for tanning, as well as ecological services such as nutrient pumping, etc. By systematically examining the reciprocal nature of rights and duties vested in owners of the fields where windbreaks are located and those vested in non-owners, the pattern of incentives to manage and sustain the windbreak system emerges.

The analysis reveals that these patterns are highly influenced by seasonality, since consumptive uses are effectively prohibited during the crop season, with enforcement and the replacement of lost trees prescribed as *duties* of nearby landowners. In light of this, landowners have the *right* to expect others to respect the seasonal prohibitions and now receive 25% of wood harvests as compensation. Non-owners have effective open access to the consumptive products in the dry season and in return they assume the duty to respect cropping season restrictions. The gestation period prior to the trees reaching maturity involves prohibitions on certain uses (e.g. grazing) and even once trees mature, camels are banned from the valley to prevent damage to trees. Marginalized people, such as herders and women with livestock, have not benefited as extensively from the programme because of these restrictions but have little possibility to influence decision-making.

The above reasoning can be extended to the incentives (or *liabilities)* facing field foresters to enforce the legal provisions governing forest use or to accept bribes for overlooking infractions, the choice depending upon interactions with superiors (who hold *powers*) and members of the communities. To date, corruption appears not to have undermined the project's effectiveness. In fact, the institutions underlying the Majjia project are largely external, in the form of a planning process and expertise supplied by an international NGO and the Nigerian Forest Code, as promulgated and enforced by the Nigerian Forestry and Wildlife Service. Nonetheless, the analysis reveals that incentives vary widely, according to season and agent, but that the sheer size of the collective benefit available to beneficiaries and a reasonable balancing of rights and duties has overcome any distributional effects and shortcomings in the institutional arrangements.

5.30 The implications of these findings for indirect incentives analysis are profound: where cooperative mechanisms are viable and can succeed, the very incentives which encourage collective action may also foster better NRM. However, this need not always be so. Collective action may be directed towards overexploitation whereas individualized efforts might have had less impact.[1] Moreover, there are likely to be cases where conditions inhibit effective collective action and where individualized property rights or state intervention are preferred (Wade 1987). With these qualifications in mind, the ensuing discussion looks at those circumstances where the incentives to cooperate are likely to be strongest and most significant for NRM.

5.31 In his original treatise on incentives for collective action, Mancur Olson (1965) argued that in cases where collective action was required to achieve an objective, a lack of self-interest in cooperating would inhibit attainment of the collective good unless there was coercion or some other form of externally imposed inducement. Wade (1987) presents a contrasting view, arguing that cooperating can be consistent with self-interest, but only when the collective benefit is sufficiently large to substantially outweigh the *transactions costs* involved in obtaining this benefit. In such cases, the individual's share of the collective benefit, less costs, would need to

[1] An example of such behaviour is the organized hunting of buffalo by North American Indians, which could be extremely wasteful but avoided depleting the large continental herds because of the relatively small human population (Low 1996).

exceed the potential benefits of not cooperating to bring about cooperation. A critical aspect is the power of sanctions to prevent defection from the collective agreement (e.g. cheating), but these may originate internally, rather than with some benevolent outside agent, as the collective recognizes its need to enforce the agreement. Moreover, the collective benefit-transactions cost view acknowledges that a lack of collective action does not necessarily indicate poor institutional incentives so much as a poor net return from organizing (Eggertsson 1990). In this sense, common property situations where collective action has not occurred or succeeded may well be efficient, in the economic sense.[1] However, it is clear that inaction may also result from market or policy failures or from institutional failings.

5.32 Various researchers have attempted to describe the conditions most conducive to successful cooperative management of common property resources. Much of this research originates with the well-known *prisoners' dilemma* game, which demonstrates that cooperative solutions may not arise when there is a divergence between the optimal private and collective solutions under particular conditions of uncertainty.[2] However, the prisoners' dilemma falls short in several respects, most notably its restriction to a single transaction and an absence of observability or monitoring of the choices made by opposing players (Olson 1996, Ostrom 1990). For this reason, the prisoners' dilemma is descriptive of only a very limited set of incentives conditions and these generally do not include the circumstances of rural communities, where observability and repeated encounters are the norm. Seabright (1993) argues that when repetition and observability are factored in, the result will be the cooperative solution, but only if:

- other players are able to retaliate in the future if the player does not cooperate, i.e. by reducing the benefits the defector can obtain from future cooperation;
- retaliatory threats are 'credible' and not too costly to implement -- thus, retaliation can be viewed as a collective action in itself and the response time and transactions costs of cooperating on retaliation must be tolerable; and,
- future benefits are substantial enough and sufficiently long-standing to provide an inducement to cooperate in the present -- in this case, face-to-face encounters in NRM prove important, as these ensure that aspects of reputation and trust enter into the incentives structure.

5.33 Bardhan (1993) argues that the game theory and evolutionary biology models illustrate that for collective action to work, discount rates cannot be too high, the interactions characterizing NRM problems must be of long duration, the rewards to defection must not be too great and punishments facing defectors must be very costly to the defector. In general, Ostrom (1990) agrees and finds that the key variables influencing the potential success of collective action are the number of decision-makers, especially the minimum number required to attain a collective benefit; discount rates, which influence the magnitude of future benefits from collective action; a similarity of interests among agents; and the presence of some individuals with leadership or other assets. A number of the conditions liable to be associated with good incentives for cooperation

[1] There may be many other social and cultural reasons for cooperation, but these may be more pertinent to other forms of activity than the management of common property, although the possibility clearly exists.

[2] The prisoners' dilemna pits two transgressors against each other by isolating them and then presenting them with selected payoffs from cooperation and non-cooperation. The payoffs depend upon an assumption of the other prisoners's behaviour and vary so that the highest private payoff comes from non-cooperation in face of the opponent's cooperation and the lowest from one's own cooperation and the opponents non-cooperation. In such cases, self-interest leads to non-cooperation on the part of both players and a middle-valued solution is attained. In contrast, the highest joint payoff is obtained from both players cooperating.

and well-functioning common property regimes advanced by various researchers are listed in Table 5-3.

5.34 Several related considerations enter into the analysis of incentives for collective action, some of which involve newer and more systematic thinking on the subject. For example, many researchers cite a requirement that small groups be involved for collective outcomes to succeed (see Table 5-3), since this ensures that the benefits of face-to-face encounters, observability, reputation effects and similar incentives elements are brought to bear. However, several researchers have argued that small size alone is not sufficient to ensure cooperative action and there may be cases where it is even disadvantageous (Wade 1987, Baland and Platteau 1996).

5.35 The issue of group size is strongly linked with issues of asymmetry in groups and group interests, as it is often argued that smaller groups are more likely to be characterized by homogeneity (Lawry 1989, Gregersen *et al* 1989). Yet heterogeneity itself (e.g. spatial or power) may not be the issue. Whereas differing ethnicity and interests in resource use can logically lead to conflicts, variations in endowments (e.g. wealth) may be less important, as long as there is a commonality of interest in NRM objectives or an 'equalizing of outcomes' (Baland and Platteau 1996). For example, Kanbur (1991) shows that fragmented plots among Indian households of differing wealth can lead to fewer disagreements over irrigation management: the dispersion of plots reduces the possibility of powerful interests meeting their own needs at the expense of others. Similarly, disparities in the wealth positions of tailenders and headenders in an irrigation system can still permit collective action to maintain irrigation systems if the joint effort of both groups is needed to undertake maintenance and improvements.

5.36 Empirical studies of cooperation in developing countries have focused extensively on irrigation water systems in South Asia (Ostrom and Gardner 1993). Wade (1987) studied the incentives for collaboration in irrigating and non-irrigating villages in Southern India and found that local geology and position on the irrigation distribution system played a critical role in determining whether cooperative institutions were present. In areas further down the distribution system, lands tend to contain more productive black soils while water supply is more limited and uncertain. These conditions result in greater incentives to cooperate because the marginal benefits from water use are higher and coordination with passing herders, who trade manure for stubble grazing, offers more to both parties.

5.37 Several studies consider the role of homogenizing influences on collective action incentives and the durability of common property arrangements. For example, Wade (see above) finds that when their own interests are threatened wealthier irrigators may block collective action. Tang (1991) studies 23 community irrigation schemes in various countries and finds that a lower variance in household incomes leads to more cooperation on rules and maintenance. Easter and Palanisami (1986) consider tank irrigation in Tamil Nadu and find that the smaller the variation in farm sizes, the more likely is the formation of water users' associations (WUAs). In a study of the resilience of common property regimes in India's dry regions, Jodha (1992) notes that smaller and more isolated villages, that have experienced less commercialization and are more independent of state intervention, have retained a larger area of common property than other villages.

Table 5-3 Conditions and Attributes of Successful Collective Action and Well-functioning Common Property Resource (CPR) Regimes

Wade (1987) **Conditions for Successful Collective Action**	**Berkes (1989)** **Attributes of a Well-Functioning CPR Regime**	**Ostrom (1990)** **Attributes of a Well-Functioning CPR Regime**
1. The smaller and more clearly defined the boundaries of the common resources. **2.** The higher the costs of exclusion technology (such as fencing). **3**. *Relations between resources and users:* - the greater the overlap between the location of the common-pool resources and the residence of the users; - the greater the demands (up to a limit) and the more vital the resource for survival; - the more the users know about sustainable yields. **4.** *Characteristics of users:* - the smaller the number of users. However, there is a minimum number below which the tasks able to be performed by such a small group cease to be meaningful; - the more clearly defined the boundaries of the group; - the more powerful are those who benefit from retaining the commons and the weaker are those who favour enclosing private property; - the more developed are existing arrangements for discussion of common problems; - the more concerned people are about their social reputations. **5**. The more noticeable is cheating on agreements. Noticeability is a function partly of how clearly defined are the resource boundaries, how near they are to users' residences and how large is the group of users. **6**. The less the state can or wishes to undermine locally based authorities and the less it can enforce private property rights effectively.	**1**. A minimum (or absence) of disputes and limited effort necessary to maintain compliance: the regime will be efficient. **2.** A capacity to cope with progressive changes through adaptation, such as the arrival of new production techniques: the regime will be stable. **3**. A capacity to accommodate surprise or sudden shocks: the regime will be resilient. **4.** A shared perception of fairness among the members with respect to inputs and outcomes: the regime will be equitable.	**1**. Individuals or households who have rights to withdraw resource units from the CPR must be clearly defined, as must the boundaries of the CPR itself. **2**. Appropriation rules restricting time, place, technology, and/or quantify of resource units are related to local conditions and to provision rules requiring labour, material, and/or money. **3.** Most individuals affected by the operational rules can participate in modifying the operational rules. **4**. Monitors, who actively audit CPR conditions and appropriator behaviour, are accountable to the appropriators or are the appropriators. **5**. Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and context of the offence) by other appropriators, by officials accountable to these appropriators, or by both. **6**. Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials. **7**. The rights of appropriators to devise their own institutions are not challenged by external government authorities.

5.38 In West Africa, there are a number of examples of traditional institutions involving cooperative behaviour. Box 5-6 illustrates several cases where local collective institutions have evolved over time or have remained relatively stable. But this is not always the case. An example of how eroding institutions can result in poorer resource management and greater social disruption, is seen in the Inner Delta of the Niger (see Box 5-3). In general, researchers find that Sub-Saharan Africa is characterized by 'institutional rigidities' which can slow the process of institutional change in response to external pressures and prevent the adoption of sustainable technologies (Perrings 1996). The formation of new institutions has typically been linked to export-oriented cash crop production and often excluded the poor in remote areas (Pretty 1995). Painter (1993) argues that indigenous NRM institutions are more common in West Africa in the southerly, higher rainfall areas where more productive and valuable resources exist and are linked to income-generating activities (Gubbels 1993), which is consistent with Wade's findings in South India (see above). Imposed institutions are also said to have had especially detrimental effects in West Africa by suppressing customary institutions (Pretty 1995). Even the well-regarded *Aménagement des terroirs* approach in Burkina Faso is said to have its limitations, given its narrow applicability to highly homogenous, sedentary communities and its lack of connections to the wider regional context or 'action space' (Painter 1993).

Box 5-6 Successful Examples of Cooperation in West African Farming Systems

A system of intensive farming referred to as *close-settled zones* (CSZ) developed around areas of high population density in **Northern Nigeria** such as Kano, Sokoto and Katsina, and date back to at least the nineteenth century. The CSZ is an agroforestry based farming system in which crops, livestock and trees are integrated. Continuous cultivation of the land is achieved by application of large amounts of farmyard manure and household wastes, some of which are 'imported' from the neighbouring city. Trees are planted at a density of 8 to 10 per ha and supply fuelwood, marketable products, some of which are used for domestic consumption as well. Livestock are penned during the rainy season, but allowed to roam freely to feed on crop residues and deposit manure in the dry season. Off-farm work is probably the most important external influence that helps sustain the CSZs. In the case of the Kano CSZ, a high proportion of households have members who work in Kano City or its environs.

In this region, the system of household organization has changed from being centered around the *gandu*, a patrilineal extended family working unit, to a more nucleated structure, the *iyali*. Previously, under the *gandu*, which had a clear hierarchical structure, land was cultivated jointly by the group. Mortimore (1989) suggests that because of land scarcity the *gandu* system survives in the Kano CSZ as sons cannot obtain land to farm on their own. Mortimore also notes that the Kano CSZ in 1988 very closely resembled its description in 1964, and is still a viable system. In contrast, Norman *et al* (1976) noted a general trend of individualization in the Sokoto CSZ as early as 1970/71. This trend has culminated in the breakdown of communal ownership of land and a move towards individual rights, a process which has been encouraged by the Islamic inheritance system.

Senegal provides an example of how a communal pastoral system may become informally privatized through cooperation and a recognition of collective interest. A conflict between Fulani pastoralists and Serere cultivators arose over land abandoned by the Serere 40 years ago and since used by the Fulani (Gueye 1994). The construction of a canal to supply Dakar with water means this land can now be irrigated and is thus very valuable. The change provoked conflict between the two tribes over who held customary rights to the land but when powerful outside interests interloped the tribes joined forces to successfully prevent outsiders from occupying their land. The two communities have agreed to jointly exploit the area on a household basis, mainly for agricultural cropping. Thus, there are instances when the security of user rights evolves towards more formal and tightly controlled arrangements on its own, and users may choose to collectively defend their user rights against external threats (Swallow 1993).

Source: FAO/IC 1991

5.39 One traditional institution of West Africa, the *tongo*, has been studied by Freudenberger *et al* (1997). These customary arrangements govern seasonal access to a number of harvested resources, including thatch grasses, fish, fruit and palm trees, sacred forests and village drinking water. *Tongo* systems may overlay traditional land tenure and usually rely on local ruling or political institutions to establish access rules and mediate conflicts. Moreover, *tongo* systems are resilient, having been recorded by Europeans as early as the 16th century, and have demonstrated their flexibility through their use in manipulating market prices and controlling supplies of exportable commodities. The study of *tongos* reveals several important dimensions of collective action in the West African context, but with wider applicability:

- mechanisms must exist for coordination, regulation and enforcement of traditional institutions, both within and among villages;
- the continuing presence and authority of village elders and the involvement of youth in enforcement provides for continuity and the intergenerational transfer of traditions;
- where the state ignores the resources administered by traditional institutions and the latter do not conflict with state level institutions, there is a greater likelihood of survival for the traditional institutions in question;
- incentives for villagers to cooperate must be tangible, immediate and useful; and,
- there is a need for the state, donors or NGOs to use planning techniques that can learn about traditional institutions and motivate formal institutions to provide legal support to the sanctions existing under customary law.

5.40 In conclusion, the development of new institutions to govern common property or to ensure uniform management of private farming systems relies on the establishment of suitable incentives at the private level. Adapting or restoring moribund indigenous institutions can be the preferred tactic in many cases, particularly where supporting formal institutions are consistent with traditional systems of sanctions. Such 'hybrid' institutions, which are part customary and part statutory can be more effective by taking greater account of the site specificity of individual resource systems and cultural norms. The *Aménagement des terroirs* approach, for example, has been most successful where it has been integrated with existing institutions, such as the role of the *Chef de Terre*. Where hybrid systems take root, the incentives for better management of natural resources are more likely to be enhanced.

B. ORGANIZATIONS AND INCENTIVES FOR NRM

5.41 As has been discussed in the previous section, there is some evidence that titles to land or increased security may increase the ability of producers to invest but not their willingness to invest. This lack of a willingness to improve their land may be due to the absence of other user enabling incentives such as available technology or information regarding new technologies, credit facilities, and other necessary infrastructure. In this regard, Platteau (1996; p. 73) notes that:

> "...there is no guarantee that new technical packages become available when farmers are ready to invest and, moreover, credit may not be forthcoming from banks, in spite of land mortgageability, if the latter feel that returns in agriculture are too low or uncertain. This issue is all the more serious in Sub-Saharan Africa, where the natural environment is very fragile and diverse, population is widely spread, and the functioning of state bureaucracies

is hampered by organizational, financial and other complex problems which affect their ability not only to foster technical change but also to provide essential inputs and services to agriculture."

5.42 Credit facilities, extension services and information about conservation technologies, can also serve as hedges against the adverse effects of insecure institutions by enabling producers to make improvements in production systems and NRM, despite these uncertainties. Policy-led intensification is suggested as a course of action by a number of studies and stresses the importance of *organizations* in promoting resource management by providing infrastructure, extension services and credit. Thus, government services must be considered a contributing factor in affecting the producer's willingness to adopt improved NRM. Whether to bridge the gap when land or user rights are not secure or to stimulate a stronger behavioural response with respect to NRM generally, government services are important features of the producer's user enabling environment.

Credit Availability and NRM

5.43 Credit availability can be an important determinant of farmer investment in certain types of conservation activities, but obviously plays a much broader role in the management of agricultural systems. For pastoralists, credit is often associated with recovery from droughts and similarly may have little or no direct association with NRM, yet may have significant indirect consequences. Since the circumstances of farmers and pastoralists differ markedly with respect to credit and NRM, we treat these separately below.

5.44 Informal credit institutions are the primary source of financial assistance for most dryland smallholders.[1] For example, Udry (1990) finds that loans between the same village or kinship group accounted for 97% of the value of credit transactions in northern Nigeria, so that segmentation along geographic lines and kinship groups is also important. He finds that collateral was seldom used and credit terms implicitly provide for direct risk pooling between creditor and debtor. Credit may also be provided formally, through extension services, donor-assisted projects and in some instances local cooperatives or agencies. These organizations can help rural producers by altering existing incentives structures to encourage production and land management improvements. However, some studies show that the creation of alternative sources of cheap credit has not worked well (Udry, 1990). Interest rates charged by traditional moneylenders remain high and substantive default rates have prevented the organizations from being self-financing. Moreover, large recurring inputs of government funds have been required. Despite these subsidies, many small farmers have been unable to take advantage of these facilities (Hoff and Stiglitz 1990). At fault may be the high transaction costs and lack of information about these alternative sources of credit, which results in fewer transactions within the formal credit system.

5.45 Three devices are commonly used in rural credit markets to limit the consequences of information asymmetries and enforcement problems (Hoff and Stiglitz 1990). These are collateral requirements, usufruct loans and rotating savings and credit associations. Collateral is usually in the form of land and, therefore, banks and other formal lenders may rely on land titles as a basis for providing credit in rural areas. In contrast, usufruct loans may be provided by the informal

[1] Arguably, the provision of informal credit can be considered as an institutional concern, but here we treat it with other non-commercial credit provided by government, donor and other agency credit disbursements as a matter of convenience.

sector, where the lender occupies and uses the borrower's land until the principal is repaid. In Nigeria, loans are procured by a system of tree pledging which involves transferring to the lender the right to harvest the borrower's trees. The harvest from the trees provides the interest on the loan, while the principal is settled separately. Rotating savings and credit associations are the third device used to limit enforcement problems and are called *tontines* in some African countries, such as Cameroon. These are similar to credit markets structured along kinship lines in that they rely on powerful social sanctions to generate trust and responsibility. Although these associations may extend beyond family groups, the element of pre-established social ties remains important. Such ties ensure regular payment of small sums of money into a common pool so that each member, in turn, can receive a large loan.

5.46 The importance of rural credit with respect to land improvement investments has been studied by various researchers. Croppenstedt and Demeke (1997) study the effect of recent agricultural policies in Ethiopia and find that farmer literacy, access to all-weather roads, access to banking, extension services, and labour availability all play a role in fertilizer adoption by small farmers. They find that with regard to the intensity of fertilizer application, smaller sized farms are more intensive. Availability of credit and supply constraints are found to be important factors in constraining fertilizer use. They conclude that "the effect of the subsidy on fertilizer consumption is small and that providing credit would be much more effective in terms of raising adoption of and level of use of fertilizer and thus contributing to increasing agricultural output". Feder *et al* (1988) draw similar conclusions for Thailand where they note that: "credit supply effects are the main source of greater productivity of lands owned legally". Carter *et al* (1991) further point out that security-induced demand effects may increase investment and productivity only on titled fields whereas credit supply effects will symmetrically increase investment incentives on all the fields, regardless of tenure status.

5.47 A principal objective of organizations and informal systems providing credit to pastoralists is to lessen the impact of drought on the household due to herd losses. At the same time, they aim to support opportunistic management strategies which enable the exploitation of wet season pasture after dry periods (Scoones, 1994). Typically, herd size is small at this time and, consequently, forage supply exceeds demand (see Figure 1-2). Toulmin (1994) points out that after a drought when livestock numbers are still low yet pasture conditions are returning to normal, a considerable gap may exist between demand and supply for fodder resources. If this persists the prolonged absence of grazing can lead to the invasion of shrubs, a consequent fall in range productivity and increased frequency of damage by bushfires. Credit-assisted restocking has played a major role in drought relief and has assisted pastoral communities in taking advantage of improved fodder productivity after a dry period (Toulmin 1986, Fry 1988).

5.48 Many pastoral communities have their own informal restocking systems, such as the *habbamae* system among the Wodaabe herders of Niger; under this arrangement, a household which loses its stock through ‘Acts of God’ receives loans of reproductive stock provided by friends and kin (Bonfiglioli 1988). However, Swift (1994) notes that while such mechanisms are effective in dealing with low levels of randomly distributed risk, they do not cope as well with more systematic risk, where livestock losses are much larger. Thus, there is a need for government interventions such as credit and insurance assistance for re-stocking and these may need to be subsidized. According to Swift (1996), financial institutions are an under-utilized instrument in helping pastoral communities in Africa. He argues that it is vital to clarify the terms under which credit is issued and to whom. He suggests that credit should be aimed at supporting restocking by

pastoral groups but that the emphasis should be on complementing existing informal local credit and insurance schemes operated by pastoral groups.

5.49 What are the implications of rural credit provision for NRM? The activities of credit organizations in most developing countries emphasize credit disbursement privately or through government programmes, but do not integrate resource conservation into their objectives (Randhir and Lee 1996). Randhir and Lee suggest that existing credit organizations could be used to enhance the observability of resource management improvements and provide financial rewards. Since credit organizations often function on a profit criterion without internalizing broader social concerns, they focus only on the farmer's credit worthiness. Restructuring contractual agreements between credit disbursers and the farmer could accommodate incentives for better NRM. They suggest, for example, that efforts made in conservation could help improve a farmer's credit worthiness. Clearly, for such an approach to work, costs incurred by private credit organizations would need to be subsidized or borne by the Government unless credit organizations were willing to internalize the costs. By properly utilizing informal credit organizations, such as *tontines*, conservation activities could circumvent the problem of credit availability in rural areas, while strengthening social responsibility and improving market opportunities.

5.50 Some agencies have been concerned that credit-supported restocking programmes for pastoralists may create undesirable incentives for NRM on pastoral lands (Toulmin 1996). For example, where stock are not distributed over a sufficiently wide area, overgrazing may occur if the range has not recovered from earlier degradation. Livestock may cause degradation when purposely concentrated and, therefore, pastoralists often try to keep stock dispersed (Stenning 1957). To avoid this potential dilemma stemming from re-stocking programmes, some management programmes have sought to strike a balance between overstocking and inefficient use of the range. For example, recent restocking efforts carried out by Oxfam, involving the Boran, Samburu and Turkana of Kenya, have largely avoided rangeland degradation. Their experience suggests that restocking schemes should aim to disperse stock originating from a relatively localized area, thus avoiding problems of degradation and disease. Toulmin (1995) has further proposed that credit be targeted at more than the alleviation of drought effects and be used to improve fodder production or to support techniques for relocating stock to better grazing areas, thus relieving pressure on range resources.

Farming Support Programmes, Research and Extension, and NRM

5.51 Although agricultural innovation may take place on its own and in response to various other factors, *farming support programmes* (FSPs) can play an important role in directing changes in farming practice and in determining the speed at which they may occur. FSPs may range from the provision of inputs such as improved seeds, fertilizers, and tillage tools to extension services providing farmers with information on improving farming efficiency and land management practices. Binswanger (1987) states that public extension services can increase fertilizer demand and aggregate output, although his empirical analysis does not show this to be a statistically significant relationship. He also reports that public research has no discernible effect on aggregate output, but it does have a positive effect on fertilizer demand. He concludes that although neither research nor extension services have a strong effect on output, this may be due to the provision of new technologies via private channels, rather than through extension services.

5.52 In contrast, Birkhaeuser *et al* (1988) provide evidence of extension's impact on the adoption of technology and the supply of individual crops. Their analysis suggests that extension services can have a strong, although variable, impact in the latter case. Furthermore, there are cross-cutting links with NRM-related institutions, such as land tenure status. For example, in the Machakos District of Kenya, policy reforms aimed at increasing agricultural investment were realized through a combination of evolutionary land rights and appropriate agricultural research and extension services at the local level (see Chapter 2). This combination created an enabling environment in which farmers were able to take advantage of information regarding soil conservation and other farming practices, resulting in improved agricultural productivity and better NRM (see Box 5-7).

Box 5-7 User Enabling Incentives in the Machakos District of Kenya

The experience of Machakos District in Kenya demonstrates the right policy framework and investments to address agricultural growth, environmental conservation and human resource development. Significant soil degradation and erosion were observed in Machakos as early as 1920. Substantial efforts have been undertaken over the past sixty years to combat these problems and to prevent further deterioration. By 1990, with nearly five times the population as in 1920, the district's agricultural production had increased more than fivefold - yet land degradation had not merely been arrested, it had been reversed. Real incomes and general welfare have increased. The ingredients to this success have been identified as :

- good macroeconomic and agricultural policy environment;
- relatively good transport infrastructure;
- land tenure security achieved through a combination of respect for traditional land rights, and slowly expanding individualized land titling;
- relatively good rural education and health services;
- excellent agricultural research and extension efforts.

In this setting, and particularly because the economic incentives were good, farmers were receptive to good extension services regarding soil conservation, moisture retention and the intensification of farming and tree planting, applying these measures on a wide scale.

Source: adapted from Cleaver and Schreiber, 1994

5.53 While noting that technology development and dissemination through agricultural research, extension, education and farm input supply are urgently needed in Sub-Saharan Africa, Cleaver and Schreiber (1995) also stress that each of these activities should incorporate soil conservation, fertility management, agroforestry, pest management, and environmentally sustainable farming techniques (see Box 5-8). Otherwise, assistance which improves agricultural production, efficiency and living conditions in the short run may cause a withdrawal of resources devoted to resource management, thereby affecting conditions in the long run. Grepperud (1995) concurs that the role of conventional FSPs with respect to soil conservation has been along these lines. He concludes that:

> "...traditional FSPs are in conflict with objectives aiming to encourage farmers to increase their effort in soil conservation. Agricultural policies in less developed countries have often had a character of being farming supportive, for example by introducing new and more efficient ways of farming... a consequence of such policies may be accelerated erosion, since the introduction of such supportive programmes increases the costs of keeping labour in soil conservation activities."

5.54 Since FSPs are often focused on labour-saving technologies, Grepperud's analysis suggests that programmes should provide conservation-supportive programmes, which are labour-saving in terms of the adoption of soil conservation measures. The model further suggests that off-farm supportive programmes may be beneficial only in the short run and may also encourage lower levels of soil conservation measures.

Box 5-8 Special Considerations Governing Agricultural Research in Sub-Saharan Africa

The following characterize Sub-Saharan Africa and must be taken into account when planning and undertaking agricultural research:

- the relative insignificance of irrigation and the large agroecological diversity in rainfed farming;
- the hostile physical environment (droughts, fragile soils) and the more complex systems of farming that African farmers employ to diminish risks and conserve fertility;
- the relative shortage of labour at peak periods of demand for farm labour, which makes mechanization (not necessarily tractorization) important; at the same time, trypanosomiasis raises unique obstacles to the use of animal power in many areas;
- inadequate macroeconomic policies, which have exacerbated deteriorating world market conditions and limited farmers' incentives to adopt new technology and expand production;
- the relatively low efficiency of agricultural support services (extension, input distribution, credit, marketing, and seed production); and,
- the fact that small countries find it difficult to sustain both adequate training facilities and a minimum research capacity to test and adapt imported technology for an often wide range of agroecological conditions.

Source: Cleaver and Schreiber 1994

5.55 The land husbandry principle of 'sustainable production through good land husbandry' rather than focusing on soil conservation *per se*, may provide more appropriate incentives than conventional extension techniques (see Chapter 1). This approach emphasizes the inclusion of soil conservation techniques as an integral part of agriculture and extension. Support for this argument is provided by Walker and Young (1986), who test for a multiplicative, positive interaction between technical progress and soil depth. The empirical evidence leads them to conclude that "the greatest increase in yields will be realized by promoting a vigorous programme of yield-enhancing agricultural research and an aggressive policy of soil conservation simultaneously." In his analysis of risk and soil conservation, Grepperud (1997) finds that if farmers are *risk averse* (see Appendix to Chapter 2), they have a greater incentive to use 'win-win' inputs which both increase output and reduce soil erosion.

5.56 It has also been suggested that farming systems research will be unable to cover the vast diversity of microecologies and cropping innovations used by farmers in Sub-Saharan Africa (Cleaver and Schreiber 1994). The need for extension services to assist in transferring *information* to researchers about the specific NRM needs of rural producers, and to facilitate experimentation amongst producers themselves, is therefore essential. These extension services not only need to ensure support to producers for production enhancement activities, but also need to ensure that production decisions reflect sustainable choices, as noted above. This point is further stressed by Odhiambo (1996) who states that Africa must "forge direct links between the farming community and the scientific research and technology development community." Odhiambo suggests that the traditional linkages between farmers and research and development have resulted in the inevitable loss of information to both sides, as extension services have failed to recognize the need for a synergistic partnership between these communities. Such improvements are needed if effective transmission of information about NRM is to be attained.

5.57 New thinking on the issue of appropriate extension mechanisms follows on from the above arguments by emphasizing a 'farmer first' approach (Chambers *et al* 1989). In this paradigm, the transfer of technology, which is the usual objective of conventional extension systems (e.g. training and visit), is superseded by a supportive approach to the development of indigenous farming and NRM technology (Moris 1991). Thus, external experts and government agricultural ministries serve a less central role. Differences between this new thinking and conventional extension approaches are described in Table 5-4. The new approach has implications for NRM, since its promotion of indigenous, low-input farming techniques may result in fewer negative impacts on NRM in comparison to the adoption of the standardized, high-input techniques pushed by extension programmes. The latter also may be poorly matched with local natural resource conditions, leading to degradation. Moreover, as the empirical evidence cited by Binswanger (1987) suggests, conventional extension has not always been very successful in any event.

Table 5-4 Rival Paradigms for Extension Analysis

Considerations	Technology Transfer Approach	Farmer-first Approach
Ultimate goal	increase local incomes	alleviate perceived problems
Purpose of extension	technology development & transfer	augment local problem-solving capacity
Means for achieving goal	high input optimized farming	low input, sustainable farming
International support	CGIAR centers	IIED, ICRAF, ILEIA
National support	Ministries and institutes	NGOs and farmers' associations
Mode of approach	top-down	bottom-up
Information gathering	experimental research	rapid rural appraisal (RRA)
	diagnostic surveys	farmers' indigenous technical knowledge
Rationale	innovation theory	empowerment theory
Screening criteria	constraints analysis	opportunity analysis
	marginal returns	perceived advantages
Main disciplines	agronomy	ecology
	agricultural economics	anthropology
Linkages between experts	by academic discipline	by problem-oriented networks
Financing	bank loans to projects	villagers' own resources
Main gurus	Borlaug, Rogers, Swanson, Benor	Freire, Chambers, Conway, Rhoades

Source: Moris (1991)

5.58 The provision of services to pastoral communities by the state and NGOs has included schools, clinics and veterinary care and has also aimed to mitigate the effects of drought through the provision of early warning systems. Early warning systems provide a means by which to monitor changing conditions during a cycle of drought and to respond appropriately (Buchanan-Smith *et al* 1992). The main services provided by the state have assumed pastoralists will maintain a sedentary lifestyle or identical seasonal migrations each year. Although mobile service approaches (e.g. veterinary care, extension, schools, health clinics) have been implemented, this appears to be the exception rather than the rule (Antenneh 1985). Services provided under the

assumption of a sedentary lifestyle can inhibit the adoption of opportunistic management strategies since they restrict flexibility and raise the risk of localized overgrazing.

5.59 Conventional livestock development has been dominated by animal breeding, veterinary science and improved forage agronomy. Only more recently has rangeland science developed an interest in non-equilibrium environments. Social science research has been largely within the domain of economics, marketing and trade, while research into institutional sociology, organizational management, social anthropology and law have been marginal. Many of the models used to introduce change may be inappropriate for pastoral communities who operate in highly variable environments. Some technology transfer models, such as training and visit, deliver specific interventions to solve the agricultural problems of equilibrium environments, such as the rainfed lands of Asia. However, these models may not adequately address the problems faced by herders in highly variable and unpredictable pastoral areas (Moris 1991, Pretty and Chambers 1993). One requirement is ecological research into the impact of pastoralist management practices on NRM.

5.60 By improving livestock services and increasing survivability in the face of drought or disease, governments can alter the 'survival algorithm', thereby reducing the incentives to hold large herds (see Appendix to Chapter 2). Swift (1994) suggests three main lines to be followed if this objective is to be met. First, a minimum set of services should be made available free of charge by the state where these cannot be provided by the market, such as the control of major human and animal epidemic diseases. Second, decentralized 'barefoot' and cost-recovery approaches to disease control should be deployed, employing indigenous knowledge. Finally, services must be made available to a highly mobile livestock population, whose numbers are capable of rapidly expanding and contracting. Such services must have the means to mount rapid campaigns to counter the effects of drought and disease that threaten herder livelihoods.

6. CONCLUSIONS AND IMPLICATIONS

6.1 This study has reviewed the literature on the linkages between government policies at the sectoral and macroeconomic levels and the incentives for households to manage their natural resource base sustainably. It has concentrated on the notion of indirect incentives, which are argued to comprise those influences on producer decision-making which are not concerned with directly bringing about changes in natural resource management (NRM) through financial or similar inducements. Moreover, indirect incentives have been grouped according to whether they are variable incentives, and thus largely influence the net returns from agricultural operations or conservation activities, or enabling incentives, which instead stem from the various institutional arrangements and support services which circumscribe the producer's decision-making environment. We have concentrated on the role of indirect incentives in West African smallholder agriculture but have taken a much broader geographical approach in presenting case studies and examples. Pastoralism, which is of immense importance in the region, has also been considered, although it is recognized that many government policies are more liable to influence sedentary farmers who make much greater use, for example, of purchased inputs.

6.2 As a general review of a very diverse topic, the study does not attempt to present a unified or consistent viewpoint throughout, in recognition of the often contradictory views held by researchers and the relatively immature state of knowledge on many aspects. For this reason, perhaps the main conclusion of the study is that very definitive generalizations concerning the linkage between specific indirect incentives effects and NRM are not appropriate at this time. Undoubtedly, sectoral, macroeconomic and even global policies towards pricing, subsidies, macro stabilization, trade liberalization, structural adjustment and institutional arrangements have effects on resource allocation at the household level. Sometimes these effects may be fairly direct and observable, as when subsidies on inputs induce more use of these, or when improving terms of trade encourage expanded export crop production. However, even though these effects can be generalized across most countries, their downstream linkage with NRM may be fuzzy, as for instance, when producers are sometimes sheltered from changes in prices at the international level and sometimes not, or expanded export crop production replaces highly destructive cropping practices with ones which are much less so or the reverse occurs.

6.3 In the majority of cases, the indirect incentives effects of specific policies are difficult to nail down and may vary from highly positive to equally strongly negative under differing resource endowments, cultural contexts and household strategies. Moreover, as even directly observable relationships, such as those cited above, represent the partial equilibrium response of households only and once the broader general equilibrium effects are considered, their influence may be less clear. The compounding and disabling effects of poverty, population growth and a poor enabling environment have further cross-cutting influences on household decision-making. Because of their subtle but pervasive nature, and their interaction with the broader process of agricultural transformation, generalizing about the impacts of indirect incentives on NRM is made even more difficult.

6.4 Notwithstanding the above, it should not be inferred that there is nothing to be learned from studying indirect incentives and their impact on NRM. Indeed, it is clear that distortions and inappropriate policies which lead to an undervaluation of the natural resource base create poor incentives for its maintenance and sustainable use. In addition, given particular country

conditions, the literature does provide suggestions as to what role indirect incentives may be playing in terms of management of the nation's natural resource base. Furthermore, there are numerous useful implications arising from the study which could help in guiding future policy-making, both at the sectoral and macroeconomic level. The sections below first address the conclusions of the desk study with respect to its main topic areas, including the identification of gaps in the literature which future research could usefully fill. Then we draw out some of the implications of the study for policy-making, concentrating on the need to recognize new thinking or paradigm shifts which may require a changing emphasis if significant improvements in NRM are to be achieved

A. CONCLUSIONS ABOUT INDIRECT INCENTIVES AND NRM

6.5 The study takes the approach that an understanding of the context of natural resource degradation is critical to any analysis of the factors causing or compounding it, and still more to assessing the incentives effects of particular policies. For this reason, an examination of the current thinking on how poverty and population factors link with degradation was undertaken, along with a review of theories about how household decision-making both influences and responds to degradation problems. This analysis culminated in the study's conceptual framework, provided in Figure 1-4. Aggregate level developments such as rapidly growing populations and persistent poverty clearly affect the opportunities and range of responses open to households. As a result, the only available reaction to changing incentives may be the adoption of unsustainable practices, leading to degradation, or else a more appropriate response to an existing degradation problem may be inhibited. In the language of several researchers, we are referring to the poverty-environment trap.

6.6 NRM problems result from a multiplicity of underlying factors and interacting mechanisms. Physical resource attributes and socio-economic factors create the conditions for land degradation to occur but may not compel it. In many cases, farmers are aware of the potential for their lands to degrade but may be constrained or discouraged from making the necessary improvements. Market and policy failures may be primarily at fault -- since farmers do not reap all the benefits of improved land management, the socially optimal level of investment in land improvements will not occur. Government policies may worsen the situation by creating the wrong incentives for conservation instead of correcting for market failure. Current thinking on the causes of resource degradation emphasizes the role of market and policy failures, inappropriate institutions and government policies, as well as the interaction of compounding or 'disabling' factors such as poverty, population growth and income or asset distribution.

6.7 One important dimension to the household response to incentives is how these incentives are perceived and how they feed into decision-making. In this regard, most researchers agree that the net returns of improved NRM are an important consideration. If it does not pay, then improved practices are unlikely to dominate more unsustainable options. Since the survival strategies of many households imply a relatively short planning horizon and arguably high discount rates, improvements whose benefits only materialize in the longer run will be discouraged. From the available research, it is clear that improvements in land management may generate a range of returns to farmers considering an investment in conservation, depending upon the technologies and physical conditions considered. Thus, statements that conservation pays or does not pay are largely specious.

6.8 While generally accepted, the above view may be somewhat narrow. For example, it ignores current thinking on the possibilities of improving cultural practices as a means of achieving soil and water conservation. Such approaches can bring about immediate yield benefits and have few out-of-pocket costs. In addition, many judgements about the efficacy of improved NRM are based upon the analysis of net returns of individual conservation technologies or packages. This view may not be consistent with the way households make decisions about resource allocation. Instead, households are liable to be concerned with the entire range of resources at their disposal and to look for ways to use these most effectively. Thus, an absence of profitability from one conservation option does not preclude adopting other more attractive possibilities. In this context, it may be necessary to identify which of the household's resources are not scarce or constraining and then examine all the options open to it for making use of these surplus resources. In Senegal, this may involve the use of spare labour, while in Mali or Burkina Faso it may revolve around the use of the more plentiful land resources. If improving NRM requires the reallocation of scarce resources then the analysis should consider the returns to these scarce factors. Thus, multi-faceted financial and economic analyses of NRM improvements and other options are needed as a basis for determining their potential attractiveness to farmers.

6.9 As a result of the recognized role of net returns in stimulating either good or bad farming practices, a key area of research has been the influence of sectoral pricing on NRM, whether of outputs or inputs. It is necessary to distinguish between aggregate production responses to higher prices, which can be manifested in higher yields or an expanded cropping area, and crop switching, which occurs when relative crop prices change and substitution of one crop for another takes place. Definitive conclusions regarding the effects for NRM from these mechanisms are not possible, particularly with respect to output pricing, since a wide range of varying crop characteristics and production responses (e.g. extensification versus intensification) must be considered and these are liable to be highly location specific. Nonetheless, it can be noted that where land of at least passable quality is available, and a sufficiently long timeframe is considered, extensifying may be a more common response to higher prices. Where marginal or fragile lands are involved, degradation can be a result. Population pressure and the longer term intensification response described by Boserup may entail land degradation problems as well, but is generally the preferred alternative for increasing production from an NRM perspective, as long as it is undertaken sustainably. In contrast, higher prices can be expected to stimulate better management of the natural resource base as it now becomes more valuable, but ancillary effects may be mixed. Certainly, reductions in the volatility of prices, or what we have called 'price risk', would seem to induce better resource management, as this permits producers to take a more forward-looking perspective in managing their resources.

6.10 Unfortunately, much of the literature on the topic of pricing and NRM takes an indirect approach: analysts must assess the effect of a price change on NRM through its first order impacts on agricultural output, whether this occurs as extensification on a crop-specific basis or in aggregate production terms, or as intensification. As a result, inferences must be made about whether erosive crops substitute for non-erosive ones, whether marginal lands are brought into production, etc. Price elasticity studies help in making such assessments but are not a perfect substitute for the comprehensive study of the full pricing and NRM linkages, which is recognized by many authors but nonetheless sadly lacking. In addition, concentrating on the assumed erosiveness of individual crops ignores the possibilities for making improvements without crop switching and the need to take a broader farming systems view in considering the overall management of the resource base. However, it must be recognized that data often are not available

for the undertaking of such studies and so there is a tendency to rely perhaps too much on 'erosiveness' measures and price elasticity analyses.

6.11 At first glance, subsidies on agricultural inputs provides a more obvious relationship with NRM, as we have already noted: where the inputs in question are unquestionably harmful to the environment (e.g. pesticides), inducing greater use would seem to be negative for NRM. However, even here we must be careful. In most cases, there are important substitute effects at work when input prices are adjusted and the implications of these for NRM must be considered as well. For example, draft animals may substitute for tractors, manure or mulches for inorganic fertilizer and IPM for pesticides. The extent to which substitution may actually occur will depend on how perfect these practices substitute for each other, their relative prices/costs and their availability, i.e. manure and mulches are often limited in supply and thus cannot fully substitute for inorganic fertilizers. Sophisticated opportunity cost calculations or household models are often needed to untangle the complex web of uses and values for these resources at the household level. Furthermore, modern agrochemicals have at least some role to play in the process of agricultural transformation, which can increase productivity and contribute to improved management of the underlying resource base.

6.12 In the macroeconomic policy realm, the study reveals that there is increasing evidence that policies at this level can have a substantive impact on NRM. A myriad of distortions created by inappropriate exchange rates, taxes and interest rates, combined with expansive fiscal and monetary policies, have conspired to alter the allocation of resources within West African economies in ways which affect NRM at the household level. For example, indirect effects stemming from macro level policies have been shown to dramatically reduce the effective prices paid to producers in Côte d'Ivoire and Ghana. Once the full economy-wide effects of such policies are taken into account, there are liable to be cases where the impacts may be much greater than at the sectoral level alone. Distortions in natural resource institutions or in pricing at the sectoral level, however, may exacerbate the undesirable effects of macroeconomic policies. Thus, without imperfections in tenure security or the underpricing of biomass resources, to cite two possible distortions, the environmental consequences of macroeconomic reforms may be significantly less or even negligible.

6.13 Many of the recommended reforms at the macroeconomic level have been bundled together under structural adjustment programmes (SAPs). Given their multi-faceted nature, SAPs are likely to have widespread but uneven NRM effects via their intended impacts on producer prices and other incentives. Levels of compliance help to condition the economic and environmental response -- members of the CFA franc zone, for example, have relatively poor records in this regard. Similarly, developments in the international commodity price arena have tended to moderate some of the intended changes in producer incentives. Case study research in West Africa supports the contention that SAPs have had both positive and negative consequences for NRM. From a base of minimal recognition of adjustment's potential impact on NRM, the multilateral agencies responsible for financing SAPs have moved towards greater incorporation of pro-active elements to address environmental side-effects. However, some researchers argue that a SAP's more important influence on NRM results from a more roundabout process involving initial effects on social structures, income distribution and other socio-economic conditions. These effects then lead to impacts on NRM via the sorts of cross-cutting, compounding effects of poverty and commercialization discussed previously.

6.14 On an even more aggregate scale, biases in the global trade system against commercial agriculture in developing countries have implications for NRM. Although African countries are generally much less excluded from Western markets than other developing countries, they still suffer from depressed prices for their commodity exports, in comparison to a distortion free trade regime. This situation has an effect on the scale of export cropping, product mix and other aspects of domestic production, some of which are negative while others are positive for NRM. Trade liberalization, while generally criticized in many quarters, has commensurately equivocal results for NRM, as evidenced in the empirical studies we review. However, most analyses concede that, while liberalization's global benefits are probably positive overall for the environment, the developing countries may incur some negative costs. Africa's experience is liable to be muted because of existing preferential trade arrangements and other factors.

6.15 The influence of land tenure and other institutions on the enabling environment must not be underestimated. The associated enabling incentives mediate the household's potential response to variable incentives, and thus help determine cultural practices and land management. Enabling incentives stemming from the alternative institutional responses to non-existent property rights (open access) and deteriorating or displaced traditional institutions were discussed. Clearly, the importance of each option can vary. For example, increased land tenure security may be unimportant if improving NRM does not require access to credit and, in general, the linkages between land tenure and investment in land improvements are not as strong as previously supposed. Thus, radical changes in traditional systems of tenure may not be necessary to enable them to operate adequately and to avoid the insecurity of access rights that can undermine NRM.

6.16 The types of institutions in place (e.g. formal versus informal) and the distribution of responsibilities governing resource use amongst these institutions, influence resource use. State intervention can be disruptive of informal, traditional institutions, leading to the conclusion that decentralization can be an attractive alternative. At the formal level, a legal framework and other features of an enabling environment support households in managing resources in a sustainable manner, even if they do not compel it. Institutional strength at an informal level seems also to be an extremely important factor affecting control over resources and in dictating cultural and NRM practices by households. Scale and asymmetry appear to be important in relation to informal institutions: small, homogeneous groups appear to work more effectively at managing resources collectively than larger, heterogeneous communities or associations. Thus, decentralization which takes advantage of local strengths can be an appealing alternative. However, naive approaches to decentralized administration may also pose difficulties. More generally, successful efforts to support indigenous common property arrangements rely upon recognition of the conditions most likely to foster collective action; clearly, these do not exist in every case.

6.17 Where support for indigenous practices or information about new conservation technologies and farming practices is needed to improve NRM, research and extension services obviously can play a useful role. However, competing paradigms (e.g. technology transfer versus 'farmer first') may have different implications for NRM. The land husbandry approach, which emphasizes the integration of soil and water conservation into farming practices rather than their promotion in isolation, may provide more appropriate incentives for adoption than conventional techniques commonly promoted by extension. For example, farmers may have greater incentives to adopt practices involving 'win-win' inputs, which both increase output and reduce soil erosion, instead of techniques that trade off these two objectives. Traditional linkages between farmers and research and development have resulted in the inevitable loss of information to both sides, as

extension services have failed to recognize the need for a synergistic partnership between these communities and have tended to disregard the value of indigenous knowledge. New thinking on the issue of appropriate extension mechanisms follows on from the above arguments by emphasizing a 'farmer first' approach. In this paradigm, the transfer of technology, which is the usual objective of conventional extension systems (e.g. training and visit), is superseded by a supportive approach to the development of indigenous farming and NRM knowledge. The new approach has implications for NRM, since its promotion of indigenous, low-input farming techniques may result in fewer negative impacts on NRM in comparison to the standardized, high-input techniques promoted by conventional extension programmes.

6.18 In more general terms, the study demonstrates the need to avoid overly narrow analytical approaches in examining the role of indirect incentives and NRM. Since many broad macroeconomic or sectoral reforms involve numerous simultaneous policy changes, it may only be possible to consider the repercussions for NRM by adopting a broader general equilibrium framework. Thus far, such an approach has received relatively little research application in West Africa. Likewise, many of the individual incentives considered interact, often in ways that may not be fully anticipated. We have already cited the case of tenure security and macro policies, but linkages also occur with credit, although this relationship may be more complex than generally thought. Similarly, agricultural research may be linked to pricing policies, so that incorrect price signals not only distort producer incentives but influence the induced innovation response, resulting in an inefficient technology mix. Moreover, when new production technologies simply mask an underlying degradation problem there may be poor incentives to respond to the problem in the short run. Macroeconomic policies governing such variables as interest rates can affect private discount rates and, hence, incentives to improve NRM, while climatic shocks such as droughts interact with market-based shocks to destabilize conditions at the farm level and make NRM more difficult.

6.19 By appealing to empirical evidence and case studies, the study has also tried to confront the numerous naive or popular notions about the indirect incentives effects of macro and sectoral policies, often based on anecdotal information alone. To cite but a few, it is often argued that male outmigration has singularly negative consequences for household management of natural resources. We are often told that promoting cash or export crops is bad with respect to NRM, or that structural adjustment and debt have highly negative effects on the environment. Accordingly, subsistence food crops are usually argued as beneficial for NRM and unabashed decentralization is seen to support improved management of the resource base. While there are elements of truth in all these statements, it is clear that the West African experience is not so straightforward -- for example, cash crops in the Sudano-Sahelian region are typically associated with a higher degradation risk while those of the forest zone further south are much more benign. The example of women, migration and NRM further helps to make the above point. In many West African countries, women are already marginalized with respect to decisions about NRM and in gaining access to resources to make improvements, prior to any migration decision. Where they have their own plots (e.g. Mali), male migration may have relatively little impact, especially if this is complemented by support from the extended family. In general, male outmigration has fewer impacts on NRM than often supposed. Similar examples are cited throughout the study. Care must therefore be taken in making such sweeping judgements about the indirect incentives effects of policies on NRM, as the reality is usually more complex.

B. IMPLICATIONS FOR IMPROVED NRM IN WEST AFRICA

6.20 Assessing the study's implications for NRM in West Africa generally, and for desertification control in particular, must take account of regional conditions or the 'action space'. The Sahelian Zone has been described as rich in land area but poor in land quality and physical and financial assets. Combined with a highly variable and harsh climate, the incentives to choose between extensification and intensification become a critical issue, and probably favour the former. The eradication of *onchocerciasis* undoubtedly reinforces this observation. Fluctuating international commodity prices and droughts in the 1970s and 1980s may have raised farmers' perception of risk and increased their concern with NRM but, at the same time, restricted their coping ability. In addition, the stagnating and declining economies of the West African coastal region mean that fewer opportunities for seasonal and semi-permanent migration exist and indeed have led to expulsions of migrant workers. Governments in the region have been increasingly willing to adopt reforms, whether structural adjustment programmes or decentralization schemes (e.g. Mali), and this is paralleled by a reduced willingness on the part of donors to provide assistance unconditionally. All these developments combine to define and modify the incentives for NRM as part of a broad, dynamic system.

6.21 Given the above conditions, conservation measures that provide good incentives to farmers in the form of increased net returns, and also meet economic efficiency criteria, are preferred to those that do not. Where these measures derive from indigenous practices, the likelihood of adoption is greater. Such measures should be the initial focus of any programme aimed at reducing degradation rates. But there are many cases in which there is a divergence between the national interest in the conservation of natural resources and the private interest of the farmer, which suggests a need to examine farm-level incentives. A careful analysis should be able to distinguish the sources of distortion in incentives, i.e. whether these chiefly originate at the sectoral or macroeconomic level. Appropriate policy analyses are required to determine whether modifications in the offending policies are possible (or desired), or whether mitigating or 'second best' approaches to correct for distortions are advised. Developing an understanding of farmers' perceptions of the causes and effects of degradation and of their likely response to alternative means of conservation and differing incentives is also an essential element in the design of any programme.

6.22 This study suggests the analysis of indirect incentives must take account of shifts in the paradigms governing thinking about NRM, as these new ways of thinking can have radical design implications. One observation is that new thinking tends towards a greater emphasis on the enabling environment over the reforming of variable incentives alone. In particular, improved pastoral system management requires a better enabling environment, since variable incentives are much less important -- for example, herders use few purchased inputs but rely significantly on marketing and infrastructure support, which are important components in opportunistic management strategies. In addition, simply targeting poverty or population growth as a means of addressing land degradation is no longer seen as the most effective route. Yet the role of policies in inadvertently fostering impoverishment and the link with the poverty-degradation trap cannot be ignored. It is instead the failure of markets, policies and institutions in the first instance, compounded by these factors, which is at the root of poor NRM.

6.23 Macroeconomic policy-making must also consider the emerging recognition of its surprisingly large influence on NRM. One of the key policy debates in the literature concerns the relative efficacies of macro level policies versus targeted environmental policies in addressing

resource degradation problems. First best approaches to resolving macro imbalances may hold the potential for worsening degradation, if failures at the sectoral level are not also addressed. While 'getting the prices right' may be one means of redressing failures at the sectoral level, 'getting the macroeconomic environment right' may be equally important to support these reforms. The points just made suggest that neither macro nor sectoral corrections implemented alone are sufficient and coordination at both levels may be the key to an effective response. Such thinking has further implications for the redesign of adjustment programmes.

6.24 We have already noted that good soil and water conservation need not involve the construction of conventional structures for the entrapment of soil and water. Instead, it may be associated with better land husbandry, such as the prevention of rain splash effects on sealing the soil surface and promotion of infiltration and *in situ* retention of rainfall which would otherwise run off and induce erosion. These practices do not require substantial inputs of capital or credit, but instead rely upon support for indigenous methods or the transmission of new knowledge and information to farmers. Increasingly, it may be the enabling incentives associated with these support services which can produce the greatest benefits for NRM, rather than smallholder credit programmes or land tenure reforms, both having largely failed in the past. Yet extension services that support sustainable agricultural technology and provide appropriate knowledge to farmers and pastoralists, are critically lacking in Sub-Saharan Africa. Guaranteeing the necessary support to producers is crucial, so that they can make sustainable modifications in their farming practices, but requires commensurate inputs from public agencies. A 'farmer first' approach, employing participatory methods and in which households are active partners in research, may be appropriate.

6.25 In the pastoral sector, a principal aim of public institutions concerned with the provision of services to herders should be to tailor support to their management strategies, which in turn are closely tied to evolving indigenous tenure systems. Typically, these include opportunistic management strategies involving a high degree of mobility and highly flexible use rights over land. Investing in public infrastructure and marketing reforms which support opportunistic management may be preferred to more conventional investments in rangeland rehabilitation or the regulation of herd size, in keeping with the new thinking in this area. Research strategies and extension facilities need to take account of the variability facing rural households and develop approaches geared towards non-equilibrium environments, if they are to support herders with sustainable production strategies. By creating an improved decision-making environment, including improved market access, government services can help herders to make sound investment decisions, taking advantage of credit facilities and other user enabling incentives.

6.26 As a final note, improved research methodologies are called for if analyses of land degradation and policy linkages are to produce more definitive conclusions. Incorporating some of the new thinking described above would lead to studies which go beyond the erosiveness of particular crops and the prospects for crop switching under policy changes, and look at broader changes in the farming system and management of its resource base. Incentives are needed to foster the development of practices which better suit agroecological conditions and the process of agricultural transformation, however slow this may be proceeding. At the macroeconomic level, there is a further need for information systems, such as green accounting initiatives, which help to highlight the plight of a nation's natural resources. Further development of general equilibrium modelling, especially computable general equilibrium models, is needed to clarify the links between existing policy stances and NRM, as well as to assess the full impact of policy reforms.

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APPENDICES TO CHAPTERS

2,3,4 & 5

APPENDIX TO CHAPTER 2

HOUSEHOLD DECISION MODELS AND IMPLICATIONS FOR NRM

1. Agricultural households may have a variety of different objectives motivating their behaviour, both on an everyday basis and in response to external shocks or pressures. Several such motivations may co-exist within a single household or amongst different households within the same community. Ellis (1993) has reviewed the various theoretical models of agricultural household behaviour; his conclusions concerning five possible models are summarized in Table A2-1. All of these models are concerned with households as optimizing entities, but having differing objective functions to be optimized. This approach provides a useful framework for analyzing household decision-making behaviour and NRM. We provide a brief overview of these models and then go on to discuss various aspects bearing on NRM.

2. Profit maximization, as a motivating behaviour in farm households, takes the perspective that such households operate principally as producing units, and thus are liable to make decisions similarly to commercial enterprises. The net returns from a production decision can be assessed *a priori* by taking into account the usual financial prices of benefits and costs, including taxes and subsidies, and then discounting these over a suitable timeframe and with the relevant private discount rate, generally as determined by rural interest rates. If households are risk-averse, they may consider the potential volatility of net returns, i.e. the variance in annual profits; or they may be reluctant to adopt production alternatives which carry some risk of disaster, even though discounted net present values may be attractive. Indirect incentives have various influences on the calculus of profitability, affecting prices of outputs and inputs, tax and subsidy levels, credit markets and therefore private discount rates. They may operate more diffusely through labour markets (population growth and migration incentives), information about production technologies stemming from research and extension, and institutions such as land tenure. The presence or absence of social safety nets, crop insurance or other interventions which reduce the risks of production variability or disaster will also have a bearing on how risk-averse producers behave.

Table A2-1 A Comparative Summary of Agricultural Household Theories

Theory	Objectives	Market Assumptions	Predictions	Practical Effects	Policy Conclusions
1. Profit-maximizing	Profit maximizing (traditional production constraints)	Competitive markets	Price efficient	Positive supply response	New resources New technology Education Credit schemes
2. Risk averse	Utility maximizing with respect to security	Natural hazards Social hazards Uncertain prices	Not efficient	Underused variable inputs	Irrigation Price stabilization Crop insurance Credit schemes
3. Drudgery-averse	Utility maximizing with respect to income/leisure	Competitive product market No labour market	Not efficient	Ambiguous - subjective responses	Cooperatives Education
4. Farm household	Utility maximizing (general)	Competitive markets	Price efficient	Positive supply response muted by general equilibrium effects	None *a priori*
5. Sharecropping	Profit maximizing	Interlocked markets	Tenant – not efficient Landowner - efficient	Tenant - underused variable inputs Landowner - interlocking for efficiency	Agrarian reform Tenant input substitution Tenant credit

Source: Ellis 1993

3. In contrast to the farmer as producer view, Chayanov (1925) recognized early this century that farm households could be both producers and consumers, and that these two roles would interact in such a way that analyzing either one in isolation might provide misleading results. Conflicts or trade-offs between leisure and work are an especially important aspect of the theory and underpin the 'drudgery-averse' and 'farm household' models of Table A2-1. Farm household analysis or agricultural household modelling (AHM) has developed as an extension to Chayanov, combining his approach and those of others within the rural economy sphere, along with Becker's approach to household production analysis (Singh *et al* 1986, Becker 1965). The two approaches maintain the same consumer-producer perspective, but the former assumes that land is limitless and that labour markets are non-existent, while the latter assumes the reverse. Both approaches place great emphasis on the importance of household time allocation and labour use, while ignoring the natural resource inputs that, when combined with this labour, result in outputs that satisfy household final demands. A description of a standard AHM is provided in Box A2-1.

Box A2-1 Agricultural Household Models (AHMs)

In this formulation provided by Singh *et al* (1986a), households are assumed to maximize their utility (U) over the production cycle, based upon consumption of an agricultural staple (X_a), a market-purchased good (X_m), and leisure (X_l),

$$U = f(X_a, X_m, X_l)$$

Utility is subject to three constraints:

a) cash income constraint,

$$p_m X_m = p_a (Q_a - X_a) - p_l (L - F) - p_v V + E$$

where,

$p_{m,a,l,v}$ = price of agricultural staple, market-purchased good, labour and variable crop input;
Qa = household production of the staple (thus Qa - Xa is marketable surplus);
L = total labour input;
F = family labour input (if L - F > 0, labour is hired; if L - F < 0, there is off-farm employment);
V = variable cropping input;
E = non-labour, non-farm income (i.e. remittances);

b) time constraint such that leisure (X_l) plus farm labour (F) must equal total available time (T),

$$T = X_l + F; \text{ and,}$$

c) a production function constraint, taking account of labour employed in production (L), variable inputs (V), land (A) and farm capital (K),

$$Q_a = f(L, V, A, K).$$

All three constraints can be collapsed into one statement by substitution, and this is referred to as full income (Y*),

$$Y^* = p_m X_m + p_a X_a + p_l X_l = p_l T + \pi + E ,$$

where π is farm profits and,

$$\pi = p_a Q_a (L, V, A, K) - p_l L - p_v V.$$

We now have a constrained optimization problem with exogenous prices (these can be endogenized as well). The first order conditions are important, as they demonstrate that production optimization decisions do not depend on choices relevant to the utility function. That is, the variables X_a, X_m, and X_l do not appear in the first order conditions, which implies production decisions are independent or separable from consumption decisions. The result of having separability is that the model can be solved recursively, or in stages. First, farm profit is maximized then this result can be used to estimate demand for the X's entering into the utility function. Such an approach is much simpler for empirical work than the case of nonseparability, which requires the modelling of simultaneous production-consumption decisions. Separability will only be present if markets exist for all goods (including labour and natural resource inputs) which are consumed and produced. Where this condition is not met an endogenous shadow or "virtual" price will exist and separability breaks down. This includes many so-called Z goods that are non-market, often home-produced outputs, possibly including environmental resource inputs such as soil and water.

4. The AHM approach is particularly suited to assessing the impacts of government policies (indirect incentives), such as the effects of price changes on household production decisions or the effects of agricultural sector policies on non-farm labour activities. This characteristic has resulted in a large number of published empirical case studies under the auspices of the World Bank and the Food Research Institute at Stanford University, and more empirical studies are continuing to appear in the journals (Benjamin 1992, Jacoby 1993, Skoufias 1994). Fafchamps (1993), for example, has estimated a household model of small farmer labour decisions for Burkina Faso, demonstrating the optimality for farmers under low productivity rainfed conditions of avoiding overly ambitious planting schemes when labour is seasonally constrained. Farm household models have also been estimated for Northern Nigeria, focusing on crop selection and substitutability in consumption (Singh and Janakiram 1986); and Sierra Leone, analyzing nutritional linkages with prices and incomes (Strauss 1986). Problems with incorporating soil and similar environmental inputs into the AHM have been largely overcome statistically, but the analysis of policies related to soil and water conservation within the AHM framework has not yet been attempted.

5. Sharecropping represents the last of the household models considered by Ellis (1993), that he sees as a form of agrarian contract: "...reducing transactions costs of exchanges in land, labour and credit markets" (p. 162). Conway and Barbier (1990) argue that tenancy is often associated with poorer land management, citing an empirical study from the hills of Nepal to support their contention. Often characterizing situations of imperfect markets or imperfect information, sharecropping results in an interlocking of factor markets. For example, landowners often advance credit to tenants, who then repay these amounts from their share of harvest revenues, linking the credit, land and labour markets (Ellis 1993). This interlocking effect has interesting implications for the study of indirect incentives. If factor markets are more closely linked, then changes in policies may be expected to have more immediate and pervasive effects on production decision-making. For example, macro-level policy changes affecting interest rates feed directly through to tenant income, through changes in credit repayment outlays. Attempts to reform sharecropping systems via land reform, or via other approaches, may have unintended effects on land management.

6. The models described in Table A2-1 refer primarily to cropping systems. Decision-making by pastoral groups may involve different mechanisms and motivations. For example, collective behaviour and the joint management of stock and productive (grazing) lands would be more common than private land use rights and production decisions made by sole households (except perhaps in Latin America). One argument advanced is that opportunistic management describes the traditional approaches to livestock management already used by African pastoralists (Behnke and Scoones 1992). If so, then the analysis of traditional pastoral management can begin with the recognition that herders, like agriculturalists, behave rationally given their circumstances.

7. Livingstone (1977) questions whether pastoralists behave rationally when they continue to increase herd sizes in the presence of overgrazing and declining rangeland productivity. He is concerned with East African pastoralists who consider a large number of livestock functions when making decisions about how many animals to hold. For example, livestock are kept:

- as a supply of meat;
- as a store of value and for investment purposes;

- as insurance against risk;
- because of the social network benefits;
- for prestige;
- to pay "brideprice";
- as a form of assistance to unfortunate households;
- for rituals and feasts; and
- as "legal" tender.

8. He emphasized that only in a few cases does the individual benefit from increasing numbers when overgrazing is occurring. These include primarily the first two functions (supply of meat, financial return) and to a lesser extent some of the other functions, but not the last two. Livingstone (1986) later concludes that the main reasons for herd size to rise over time for a whole community, as opposed to an individual family's holdings, are for financial return and as insurance against risk or uncertainty. These two aspects are discussed separately and in more detail in the following two sections.

9. What then are the linkages between incentives, producer behaviour and NRM? As Perch *et al* (1988) point out, and as suggested by the pastoral example given above, natural resource degradation may come about as a rational response to signals or perceived incentives in the producer's environment, not because producers lack understanding of the consequences of their actions. Which incentives will have the most influence on decision-making is determined by the objectives of the household, i.e. profit, risk avoidance, while its response may be conditioned by the household's attributes, i.e. socio-economic characteristics, level of technology. We have already pointed out the cross-cutting and complex ways in which poverty and migration opportunities may come into play here (see Figure 1-4).

10. Having detected a change in the decision-making environment, producers may respond in various ways, with adaptive responses being recognized as especially important. Adaptation to 'perceived incentives' such as external shocks or policy changes, may itself be the source of environmental degradation. For example, farmers faced with the prospect of declining incomes or productivity may respond by migrating to marginal areas or expanding their current cropped area onto more fragile lands, resulting in degradation. They may also make sustainable changes to their cropping or grazing system, such as switching to less erosive crops or adopting soil conservation and fertility enhancement measures (Pearce and Warford 1993). Okafor (1986) describes the multicropping systems of Southeastern Nigeria as a response to declining land productivity in the face of mounting population pressure. In this case, the adaptive response is beneficial from an NRM perspective. As a further alternative, rural households may seek off-farm employment or develop other income-generating opportunities so that reliance on cropping or grazing is reduced and degradation may be less likely to occur. We can also add that farmers may adopt unsustainable cropping or grazing practices on existing farmed lands in order to boost output or income, including switching to more erosive crops or intensification and the increased use of environmentally harmful inputs. In this regard, a number of the indigenous soil and water conservation strategies used in the Sudano-Sahelian region of West Africa have had mixed effectiveness and newly adapted strategies may be required in some locations (Roose 1977).

11. Adaptation to external changes and the follow-on potential for natural resource degradation as a result of the decisions taken, is only one element in the adaptation process. As degradation arises, households may be forced to respond further and make new adaptations. But if a degradation problem constitutes the shock to the farming system, then responses can only occur if the problem is perceived by the household. Evidence suggests that in most cases, farmers are aware that their productivity is declining when there is an underlying resource degradation problem, as long as technical changes such as fertilizer use or the planting of improved varieties do not mask it (Mortimore 1989, Barbier and Bishop 1995). Clearly, this is a first stage in the decision-making process, as demonstrated by the conceptual framework presented in Chapter 1.

12. Once aware of the degradation problem, farmers may employ any of a number of strategies, including the adoption of new technologies or modifications to existing management practices (see Chapter 1). Barbier and Bishop (1995) list the following factors emerging from empirical research as liable to influence farmers' responses to a perceived degradation problem; all are subject to influences from indirect incentives:

- "the value the farmer attaches to future as opposed to present income, which may reflect the farmer's attitude to risk and uncertainty, as well as the level of household poverty and access to credit and off-farm income;
- the costs of current soil conservation efforts to the farmer, which in developing countries may reflect the availability of labour, purchased inputs, and credit for conservation efforts;
- relative input and output prices which determine the current profitability of erosive versus less erosive cropping systems, including fluctuations in these prices over time;
- the future returns of the farming system, as affected by technological improvements and by the impact of current cultivation techniques and crops on soil fertility and future yields."

13. Mortimore (1989) mentions several of the strategies employed in the northernmost states of Nigeria, in response to degradation: they may abandon their land; continue to farm it as before, ignoring the situation but having few alternatives; or they can make land improvements, subject to the opportunity costs of changing their farming practices, i.e. incorporating crop residues rather than using them for fencing, fuel or livestock feed. Indirect incentives play a role by determining the relative attractiveness of the potential responses available to farmers, through price structures and institutional regimes, for example. If land improvements are to be made, then certain characteristics of the options available may enhance the likelihood of their adoption, including quick pay-offs, high financial returns, low risk, minimum of foregone benefits, low external inputs, ease of demonstration, linkage with an existing management practice and social acceptance (Ellis-Jones and Sims 1995).

APPENDIX TO CHAPTER 3

EVIDENCE OF AGRICULTURAL OUTPUT PRICE IMPACTS ON NRM

14. Researchers have attempted to quantify some of the impacts portrayed in Figure 3-1, but there is still a paucity of analysis linking pricing effects to NRM (Barbier and Bishop 1995, Pearce 1993, Pearce *et al* 1989). The analysis begins with changes in prices and first considers their effects on producer cropping decisions. Secondly, we look at the impact that individual cropping choices have for NRM. Obviously, some crops are more desirable from a land management point of view, while others may be more likely to lead to soil loss, for example. We are interested in the quantitative effects of both sector-wide changes in prices and relative price changes, and the resulting incentives created for soil and water conservation. We can begin with the concept of price elasticity, which refers to a measurement of the percentage change in output associated with a given change in the output price, the latter usually presented as one percent. Use of empirical price elasticity estimates offers us a means to examine these quantitative effects, although caution is required, given the varying methodologies used for estimation and problems of omitted variables and other technical issues (Mamingi 1997, Barbier and Burgess 1992).

15. Of principle interest is the distinction between aggregate supply elasticities (sector-wide price changes) and price elasticities for individual crops (relative price changes). Aggregate supply elasticities tell us how much combined extensification and intensification will occur when overall agricultural sector profitability improves, but tend to be quite low for most regions, including Africa (Binswanger 1989), although Chhibber (1988) suggests the greater prevalence of 'parallel markets' in Africa reduces the effectiveness of changes in official prices, where the latter are lower (recall Table 3-1). Aggregate supply elasticities in the short run have been estimated at about 0.18 by Bond (1983) for a sample of nine African countries, and at 0.21 in the long run. Thus, a one- percent increase in sectoral output prices would result in a 0.18 percent change in aggregate output, a rather modest response. Jaeger (1992) similarly finds a range of 0.1 to 0.3. We can therefore make the observation that sector-wide price increases could result in the extension of cultivation to marginal, fragile areas (extensification) and in an increasing demand for potentially degrading farm inputs (intensification), but that this combined response may not be dramatic. Barrett (1991) suggests that a small difference between the short and long run elasticities, as indicated for Africa, may signal a poor soil conservation response to price, as the benefits from some soil conservation improvements tend to materialize over a longer period and may even reduce production in the short run. However, for many land management improvements, this need not be the case (Shaxson *et al* 1989).

16. Table A3-1 shows that price elasticities of supply for individual crops tend to be higher than the aggregate supply elasticities discussed above. Producers respond significantly to changes in relative crop prices, even if not so heartily to sector-wide price adjustments. The results evident from a comparison of aggregate supply and individual crop price elasticities suggests (but does not guarantee) that producers respond to relative price changes by substituting among crops, rather than by simply increasing their aggregate production (Barbier and Burgess 1992). To state this with more confidence would require cross-price elasticity estimates, which indicate the response in crop production to changes in the price of other crops. Limited evidence from Malawi shows that increasing groundnut prices reduce sorghum production while an increase in the cassava price is associated with an increase in sorghum production (Weaver 1989). In semi-arid India, cross-price responses among various cereals vary from -0.1 to -0.4, while between cereals (wheat, sorghum) and pulses the signs generally reverse, reflecting complementarity in cropping, but the effect is quite weak (Binswanger 1989).

Table A3-1 Short and Long Run Price Elasticities of Supply for Individual Crops in Africa

Crop	Countries	Short Run Elasticity	Long Run Elasticity	Studies
Cocoa	Ghana, Cameroon, Africa (7 countries)	0.22 - 0.68	0.45 - 1.81	Fones-Sundell, Jaeger, Behrman
Coffee	Africa (various country combinations)	0.12 - 0.64	0.44 - 1.33	de Vries, Jaeger, Maitha
Cotton	Uganda, Tanzania, Nigeria, Sudan, Africa (11 countries)	0.25 - 0.67	0.25 - 0.38	Diejomoah, Medani, Frederick, Jaeger, Mshomba
Groundnuts	Nigeria	0.24	0.24 - 0.79	Olayide, Fones-Sundell
Maize	Kenya	0.33	0.66	Fones-Sundell
Palm Kernels	Nigeria	0.22 - 0.28	0.22 - 0.28	Oni, Diejomoah
Palm Oil	Nigeria	0.29 - 0.81	0.29 - 0.81	Oni, Diejomoah
Rice	Mali	0.27	n.a.	Fones-Sundell
Rubber	Liberia, Nigeria	0.04 - 0.14	0.22 - 1.75	Ghoshal, Olayemi & Olayide
Tea	Tanzania, Africa (4 countries)	-.04 - 0.35	n.a.	Jaeger, Mshomba
Tobacco	Malawi, Nigeria	0.48 - 0.95	0.48 - 0.82	Dean, Adesimi, Fones-Sundell

Sources: Mamingi 1997, Barbier and Burgess 1992, Bond 1983

17. One means to examine the importance of crop switching is to look at whether price increases induce farmers to intensify, and thus raise yields on existing lands, or extensify, which may involve crop switching or the bringing of idle, possibly marginal lands, into production. Although Table A3-1 cannot shed light on this issue, some evidence is available from area and yield elasticity measures for individual crops. Short run agricultural area elasticities (price) for various African countries tend to be quite large for cash crops such as coffee, cotton, tobacco and cocoa, many in the range of 0.5 to 0.7 (Mamingi 1997). This suggests a relatively strong areal response to price changes. In contrast, Cleaver and Schreiber (1996) estimate a number of short run yield elasticities for African subsistence crops such as cassava, maize and sorghum, and find much lower elasticities, most in the range of 0.1 to 0.2. Since cash and subsistence crop responses to price changes might be expected to differ, it is difficult to draw conclusions from this data. Nonetheless, it is suggestive that extensification on an individual crop basis, including crop switching, may represent a more important response for at least some crops in Africa, which concurs with most other assessments (Barbier and Bishop 1995, Pearce 1993, Pearce *et al* 1988, Repetto 1986).

APPENDIX TO CHAPTER 4

AN OVERVIEW OF STRUCTURAL ADJUSTMENT IN AFRICA

18. Adjustment commenced in Africa with Senegal in 1980, with this programme followed by one in Ghana several years later, and programmes in many more countries subsequently. In a comprehensive review of structural adjustment in Africa, White (1996) argues the essence of these programmes is the dismantling of "the system of state control erected in African countries since independence" (p. 786), to which we can add the critical need for devaluation. He goes on to describe African SAPs as follows:

> "A central element of adjustment programmes is market liberalization: of credit markets (financial liberalization), factor markets (abolishing minimum wages and removing capital subsidies), external trade (abolishing quotas and reducing import tariffs and export taxes), internal trade (removing state monopolies and eliminating price controls and the associated subsidies) and the foreign exchange market (initial devaluation followed by a shift to a floating exchange rate regime). Adjustment is also about reforming institutions: mainly by slimming down the public sector (retrenchment, closure and privatization or contracting out), but also by promoting private activity (revising legal codes and investment incentives and removing government impediments to enterprise, including state monopolies). Finally, adjustment programmes may contain, or start with, stabilization measures, attempting to bring down inflation mainly by restricting the government deficit, but perhaps also with a squeeze on credit to the private sector." (p. 786-787)

19. The relative importance of each of the policy measures comprising SAPs can be assessed from the conditions attached to the relevant loan agreements. For the fiscal years 1989 to 1991, 52% of African SAP-related loans involved conditions governing trade policy, 40% had conditions relating to agricultural policy, 24% had conditions attached to the financial sector and 14% had conditions associated with exchange rate policy. Regarding public sector management, most SAPs had provisions for expenditure policy (81%) and public enterprise reforms (67%), while social policy adjustments were present in 24% of SAPs. Table A4-1 shows some of the provisions of West African SAPs with respect to administered output prices, export taxes and input measures, such as subsidy and import duty adjustments. From the Table, it is clear that pricing measures have favoured producer price and input subsidy changes over tax and tariff modifications.

20. Amongst policy measures having a bearing on variable incentives at the producer level, trade policy (including exchange rates) has been the most prominent element in African SAPs.[1] Exchange rate devaluation has typically been one of the most important SAP components outside Africa, but seems less important within the continent (see above), perhaps because of the influence of the franc zone. Lensink (1996) notes that import reforms have covered three key areas: the allocation of foreign exchange, elimination of non-tariff barriers (NTBs) and tariff reductions/removals. Many African nations outside the CFA franc zone use licensing and foreign exchange rationing as a means of regulating importing activities. Under structural adjustment, attempts were made to reduce such restrictions and allow an open market in foreign exchange. Similarly, tariffs were to be lowered and simplified, the latter by reducing the range of different tariffs. On the export side, liberalizing foreign exchange use and reducing export taxes and regulations were the cornerstones of most SAPs.

Table A4-1 Agricultural Output and Input Price Provisions in Structural Adjustment Programmes in West Africa (1988 - 1992)

Output/Input	Number of Countries		Countries Affected
	Producer Price/ Subsidy Adjustment	Export Tax/Import Duty Adjustments	
Agricultural Outputs:			
Food crops (rice, maize, wheat, sorghum, and other foodgrains)	4	1	Burkina Faso, Côte d'Ivoire, Mali, Mauritania
Cash crops (cotton, tobacco, groundnut, oil crops)	6	4	Benin, Burkina Faso, Cameroon, Côte d'Ivoire , Gambia, Guinea, Mali
Tree crops (coffee, cocoa, palm oil, tea)	6	3	Cameroon, Côte d'Ivoire, Ghana, Guinea, Guinea-Bissau, Sierra Leone, Togo
Livestock	1	1	Côte d'Ivoire, Burkina Faso
Agricultural Inputs:			
Fertilizers	5	0	Benin, Burkina Faso, Cameroon, Ghana, Togo
Agricultural chemicals (pesticides, herbicides)	3	0	Benin, Côte d'Ivoire, Togo

Source: Warford *et al* 1994

Note: Producer price and export tax adjustments refer to outputs, while subsidy adjustments and import duty changes refer to inputs. The following input groups were not addressed in West African SAPs but were present in other countries/regions: agricultural machinery, spare parts and implements; interest on agricultural credit; seeds and planting materials; land rental rates; animal feeds/livestock services; and irrigation water.

21. Other agricultural sector reforms of note cover the marketing of agricultural outputs and inputs. Under Nigeria's SAP, all marketing organizations were to be scrapped, while in others only targeted organizations were to be eliminated. Some SAPs maintain marketing organizations but subject these to reforms: in the cotton areas of West and Central Africa, producers were to be

[1] The following paragraphs describing the contents of African SAPs relies heavily on Lensink (1996).

paid a fixed amount initially and then receive a share of profits once final export sales were tallied, on a trial basis. In contrast, some SAPs allow private marketers to spring up alongside government marketing organizations, such as for coffee and cocoa in Côte d'Ivoire. Modifications to input supply, where this has historically been a government-provided service, accompany the elimination of subsidies in some cases (farm support programmes are discussed in Chapter 5).

22. Outside the agricultural sector, reforms have affected the public sector, financial sector and labour markets. Reducing the size of governments and by implication, the budget deficit is an important dimension of African SAPs, as noted above, but is especially relevant for Benin, Ghana, Guinea, Nigeria and Senegal. Reducing subsidies, privatizing viable non-strategic public enterprises and liquidating the non-viable ones are all aspects of improving public sector management. In the financial sector the emphasis has been on creating real positive interest rates -- this occurs where the nominal interest rate exceeds the rate of inflation -- through such measures as tightening credit, which can have 'trickle down' effects for smallholder lending along the lines discussed earlier. In the labour market, efforts were targeted at reducing structural rigidities that limit labour mobility, such as eliminating wage indexing and other public sector privileges. We have already noted the important influence that migration and the opportunity costs of labour have on NRM in the Sahelian countries (see Chapters 2 and 3).

23. Have African SAPs been successful? This is a difficult question and one which depends on the objectives success is measured against, the country in question, the vested interest of the reviewer (World Bank reviews are often highly positive while those of environmental advocates, for example, are frequently very negative), the time span considered and a host of other factors. Nonetheless, numerous attempts have been made to assess their effectiveness in Africa, many of which have been reviewed by White (1996); a summary from that review is provided in tabular form as Table A4-2 at the end of this Appendix. On the basis of the impact on economic growth, these studies suggest there has been a positive short term effect, if more broadly defined stabilization is considered as the relevant policy package, rather than adjustment alone (White 1996).[1] For the agricultural sector, Binswanger (1990) presents data for adjusting versus not-adjusting countries in Sub-Saharan countries for 1970 to 1987 which suggests that a gap has developed between the two groups in later years, although per capita food production shows no such trend. White (1996) concludes that the prospects for long term growth stemming from adjustment are less promising, arguing that the necessary infrastructure, human capital and other prerequisites have not been put in place.

24. If structural adjustment has not been as successful as hoped, the reasons can be quite readily identified. Lensink (1996) points out two factors which must be considered in examining the impact of adjustment:

- the extent to which countries have actually adopted the prescribed measures included in the SAP, i.e. 'compliance';
- the success of the particular adjustment measures, once adopted.

[1] Stabilization refers to programmes geared towards "a recovery of the imbalances in the balance of payments, a decrease of government deficits and a decrease of the money supply in order to control inflation and decrease macroeconomic instability" (Lensink 1996, p. 57).

25. He notes there appears to have been reasonably good compliance in Africa, and certainly no worse than elsewhere. For example, 65% of loan conditions relating to trade and exchange rates have been fully met, while 19% have been partly met and 16% have only been met to a limited degree. This compares to rates outside Africa of 55%, 19% and 22%, respectively (Nash 1993). It is not clear that those conditions met fully have been the most important ones, and there is even some evidence to suggest that they have not (Lensink 1996).

26. In general, the CFA franc zone countries have showed lower compliance, and as a result of the limitations imposed by an exchange rate linked to France, have generally demonstrated a poorer adjustment performance overall (Munasinghe 1996). West African countries identified by the World Bank as having made substantial economic policy changes under SAPs include non-members like Ghana, the Gambia, Burkina Faso and Nigeria, while members such as Mali, Mauritania, Senegal and Niger have made only small positive changes. In Sierra Leone, Togo, Côte d'Ivoire and Cameroon, economic policy is thought to have actually deteriorated under adjustment (World Bank 1994). The World Bank (1994) claims to have found a correlation between improvements in economic policy and better economic performance, but many critics doubt the reliability of this conclusion (White 1996, Lensink 1996). For example, several authors argue that price and narrow adjustment reforms alone are not capable of bringing about the desired improvements in economic performance (Diakosavvas and Kirkpatrick 1990, White 1996).

Table A4-2 Review of Case Studies Assessing the Impacts of Structural Adjustment in West Africa

Country	Impacts : Growth	Agric.	General Conclusions	Source
Cameroon	x	x	Extreme external shock suffered by the country has meant that adjustment has initially been expenditure reducing, and expenditure switching has been constrained by membership in the CFA franc zone.	Blandford *et al.* (1994)
	n.d.	n.d.	Focus on social impact: considered to early to judge programme impact, but severe constraints within which it operates (including franc zone) are noted.	Ndongko (1993)
Côte d'Ivoire	~	~	Initial adjustment efforts in early 1980s had some payoff but in latter part of decade required policy reform (notably real exchange rate depreciation) not achieved. Negative outcomes (declining real GDP an increasing poverty) are interpreted as showing the costs of inadequate adjustment.	Demery (1994)
Gambia	+	+	Growth has been restored, but the country will remain dependent on foreign aid to meet debt service obligations for the foreseeable future.	Jabara (1994)
Ghana	+	+	Success of the programme to date is only a prologue for sustained growth and poverty alleviation, which will require further investment.	Alderman (1994)
	+	+	Despite adverse external factors, a far reaching programme of reforms has been implemented with strong government commitment; however, more could be done to restore business confidence.	Leechor (1994)
	+	+	Ghana's experience of adjustment has been positive, bit one must be cautious in drawing lessons for other countries.	Mistry (1994)
	+	+	Growth has been restored, though this has been modest in agriculture, which is the backbone of the economy; moreover, many groups have suffered from unemployment and lower real wages.	Sowa (1993)

Country	Impacts : Growth	Agric.	General Conclusions	Source
Guinea	x	x	Agricultural recovery has been held back by non-price factors, illustrating that the reform programme is necessary for sustained recovery but not sufficient.	Arulpragasam & Sahn (1994)
Niger	~/x	~/x	The reforms to date have been modest and only affected the formal sector, which is only a small part of the economy.	Dorosh (1994)
Nigeria	n.d.	n.d.	Focus on health: reform programme has adversely affected access to health services and nutritional status through rising prices and the squeeze on the health budget.	Popoola (1993)
	n.d.	n.d.	Cuts in education subsidies, resulting from economic crisis and market-oriented philosophy of adjustment, have led to declining quantity and quality of education services.	Fadayomi (1993)
	+	+	Adjustment programme initially implemented with high national commitment and had positive impact, though inadequate protection for social sectors; the reform effort faltered in the late 1980s.	Faruqee (1994)
	n.d.	n.d.	Adjustment has resulted in falling real wages and employment, which has particularly affected formal sector workers.	Fashoyin (1993)
Senegal	n.d.	-	Focus on social impact: Although adjustment has been necessary it has been carried out in such a way to adversely affect agriculture and, hence, the well being of the majority of the population.	Kane (1993)
	+/x	x	The efforts at reform have been fragile; results achieved are both fragile and modest, and unlikely to provide the basis for sustained growth; the supply response has been mostly from the informal sector.	Rouis (1994)
Sierra Leone	~	~	Reform efforts have been weak, with consequent poor economic performance that has led to inadequate expenditure on health and education.	Elliot (1993)

Source: White 1996
Key: (+) positive effect; (x) negligible effect; (-) negative effect; (~) policy not implemented; (n.d.) not discussed

APPENDIX TO CHAPTER 5

LAND TENURE AND NRM

27. Traditional resource management systems, governing both cropping and pastoral-based systems, have suffered in recent years from excessive drought, rapid population growth and the evolution of what are now increasingly recognized as inappropriate social and economic policies. A number of these management systems, concerned with what can be called 'controlled access resources', operate in Africa (see Box A5-1). These govern the way such resources are used and the manner in which resources are made available to or transferred amongst users. Thus, actual *ownership* of resources need not be the prime focus of property rights analysis with respect to NRM. In fact, communal arrangements appear to be multi-layered systems with various overlapping tenure arrangements. Rights with respect to land and resources are thus complex and multi-faceted and can include land rights, water rights, tree rights (where rights to cut fodder from trees or to the cut the tree may rest with different people or communities) and rights of passage (see Box A5-1). Hence, the concept of tenure security, as determined by the individual use and transfer rights held by people over resources, may be a more appropriate focus. Borrows and Roth (1990) define tenure security as: "...the perception of losing a specific right to cultivate, graze, fallow, transfer or mortgage". In general, this concept is preferred as the focus of attention to broader terms like land or resource tenure.

Box A5-1 Definition of Property Rights Systems and Types of Access Rights

Land or resource tenure can be defined as the "terms and conditions on which natural resources are held and used." It can be described as the manner in which resources are owned, i.e. the relations of property that are sanctioned by individuals and the wider society in which they live (Lane and Moorehead 1994). A property right is a claim to a benefit stream that some higher body, such as the state, will agree to protect. Property is not an object but rather a social relation that defines the property holder's position vis-à-vis other individuals with respect to something of value. Property is a triadic social relation involving benefit streams, rights holders and duty bearers (Bromley *et al* 1992).

It is important to make a distinction between *controlled access resources* and *open access resources*, the latter referring to resources which are not owned by anyone, are not subject to tenure rules and are, therefore, not property at all. Controlled access resources, on the other hand, are managed either by the state (national property), communities (communal or traditional property), or by individuals (private property). Lane and Moorehead (1994) argue that all pastoral resources in Africa are held under controlled access regimes, often in communal form. Communal tenure confers access to land based on lineage or membership in a group defined by common descent (Bruce 1986). It differs from western systems of tenure in that land titling is not as uniform and land markets are less established but it has been argued that users do not customarily lack security of tenure or a strong sense of property with respect to their land (Bruce 1986).

There are also distinctions to be made with respect to use versus transfer rights. *Use rights* are the right to grow annual crops for one or more years, with or without the right to make the choice of crop; grow perennial crops and make permanent improvements; collect fruits or firewood, cut trees, graze livestock, and be buried on the land. In contrast, *transfer rights* are the rights to register the land and lend, rent, mortgage, pledge, bequeath, give or sell the land, with or without approval from elders. The rights defined above may belong to one person, one household or to many people. Rights to graze livestock, for example, may belong to both farmer and herder. Transfer rights may or may not allow permanent transfer, or they may allow land to be bequeathed but cultural constraints may demand matrilineal or patrilineal heritage. Complete transfer rights would allow the current operator to sell land to anyone.

28. Indigenous systems have sometimes autonomously evolved from a system of communal property rights (and individualized user rights in some cases) to individualized property rights. There has also been considerable pressure to replace customary rights with registered land and land titling programmes, based on the argument that communal tenure systems are inherently destructive and inevitably lead to situations of open access and land degradation — the so-called Tragedy of the Commons hypothesis (Hardin 1968). This hypothesis concerns the open-access nature of some communally-held land. For example, animals may be held individually, while the range is owned by everyone or none. As a result, the hypothesis states that herders will always invest in more animals because benefits accrue to individuals while the costs of overgrazing are borne by all users. The argument naturally leads to the stand that privatization of the grazing resource is essential to avoid degradation. There has been considerable debate on the validity of the strategy of the commons hypothesis, because of its erroneous contention that commonly held land will always be undermanaged or overexploited and, therefore, requires privatization.

29. Critics of traditional tenure systems in Sub-Saharan Africa have argued that these systems often lead to inefficient resource allocation, constrain agricultural productivity and result in environmental degradation. The main cause of these inefficiencies is thought to be the ambiguous or communal nature of many indigenous land tenure systems, resulting in tenure insecurity and disincentives to invest in the better management of land (Demetz 1967, Johnson 1972). This so-called *property rights school* of thought recognizes communal rights to land as general rights to use land which fail to include the right to deprive others of access to it, except by prior and continuing use.

30. As long as land is abundant the absence of property rights does not matter, since "...there is no positive value to society of creating clearly defined property rights in land" (Johnson 1972). However, when the gains from internalizing any externalities resulting from communal land rights become greater than the costs, due to scarcity of land or increasing land value, for example, economic efficiency justifies the replacement of communal with private ownership rights. As Davis (1971) states: "...by assigning definite property rights to specific individuals or groups the consequences of misuse and the returns to investment in future production are both made specific to the holders of those property rights." As a result, proponents of the property rights school argue that indigenous tenurial systems provide inadequate security to producers to carry out land improvements or to induce lenders to assist in the financing of such investments (Dorner 1972).

31. With particular reference to Sub-Saharan Africa, there are a number of counterarguments to this stand, based on new and emerging evidence that indigenous land rights are not ambiguous, not always communal and flexible enough to cope with increasing land scarcity. Contrary to the property rights school of thought, some researchers contend that traditional tenure systems are dynamic and capable of responding to changes in factor prices, agricultural commercialization and population increases, while continuing to provide adequate tenurial security for investment (Moroha 1985, Boserup 1981, Cohen 1980, Bruce 1980). For example, the *assurance problem* approach suggests that communal forms of property rights may provide sufficient security and incentives to operate as efficient management systems (Runge 1984). But these management systems must be recognized and understood. The World Bank Drylands Management Study concluded that a lack of understanding of traditional production systems in dryland areas is one of the main reasons for the failure of development efforts to bring

about positive and sustainable change and economic improvements in these areas (Seve *et al* 1990). A further, related approach is the *evolutionary theory of land rights*, which argues that: "...indigenous land rights, under the impulse of market forces, are capable of significant autonomous evolution in a beneficial (efficiency-enhancing) direction" (Platteau 1994, Swallow 1993).

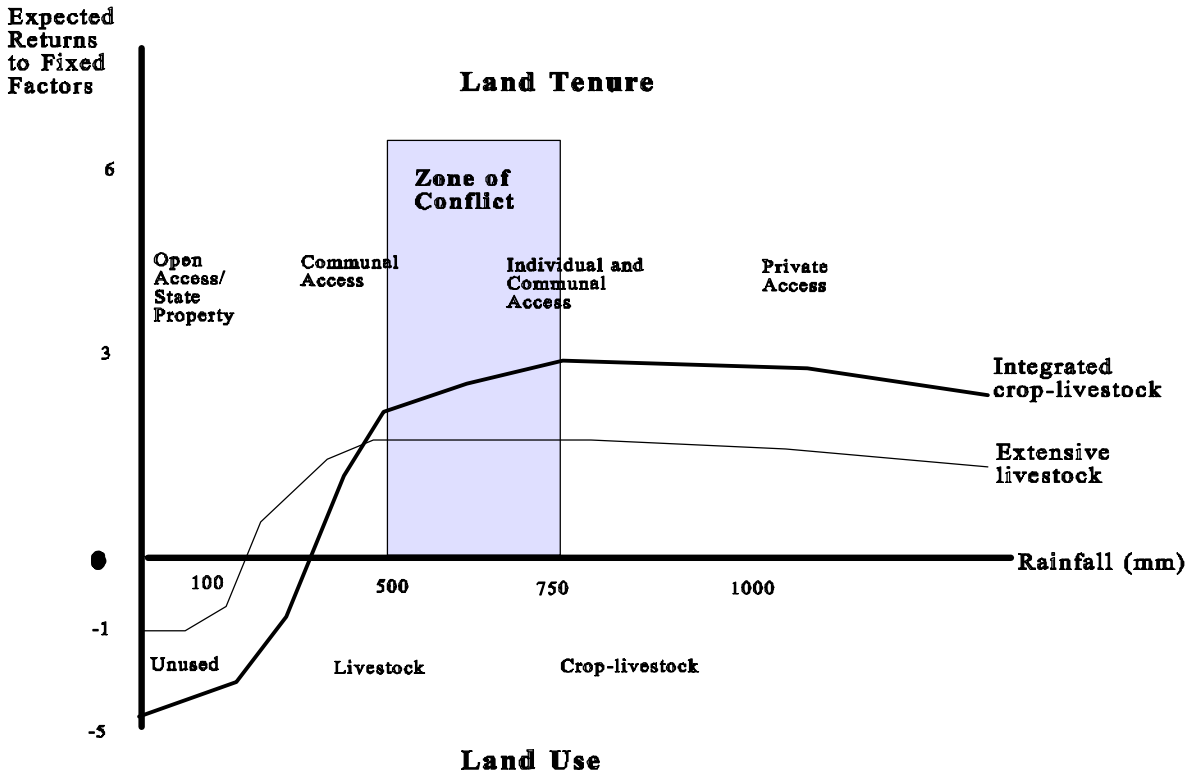
32. Traditional pastoral tenure systems are additionally rooted in the ecology of rangeland systems, which is associated with uncertain rainfall and productivity. As discussed in Chapter 1, recent ecological thinking on range management is moving away from conventional equilibrium concepts to the management of non-equilibrium environments (Scoones 1993, Ellis and Swift 1988, Clements 1916). Under this approach, vegetation dynamics are recognized as being controlled by the variability in rainfall. Livestock do not graze individual pastures permanently, instead making use of variable fodder resources using a 'tracking' strategy (Ellis 1994, Scoones 1994). Such a strategy involves the matching of available feed supply with animal numbers at a particular site, with the implication that livestock do not attain densities necessary to have a negative effect on vegetation or productivity (Sandford, 1994). Traditional tenure systems and rules governing resource use have developed to facilitate cultural practices such as tracking, which in turn influence resource degradation and range productivity (Lane and Moorehead, 1994). Many pastoral systems may exhibit a complex layer of multi-tenure arrangements dependent on the nature of the resource.

33. The complex bundle of rights associated with traditional agricultural and pastoral tenure systems makes it difficult to impose changes from the outside, through land reforms, registration or titling programmes, without creating equity problems. As noted by Platteau (1996): "...when customary group rights and community control are extinguished by a procedure of registration/titling, there is a transfer of transaction costs from local land authorities to the state; it is the inability of the state to bear them that accounts... for the failure to adjudicate and register all rights existing under the customary system". It is now increasingly realized that this failure of land registration programmes to record accurately all existing land rights invariably results in:

- uncertainties for vulnerable sections of local populations;
- deterioration in the efficacy of traditional institutions that earlier provided economic security to all members of the community; and,
- increasing numbers of land disputes.

34. This is affirmed by Swallow (1993), who notes that land rights evolve in accordance with land productivity. Illustrated in Figure A5-1, Swallow's model allows a typology of land tenure systems to be linked to a range of production strategies from extensive livestock systems to integrated crop-livestock systems. The model argues that where variability of production is high, opportunistic management strategies prevail and optimal tenure systems are flexible. As rainfall increases and variability of rainfall declines, cropping systems begin to predominate, eventually displacing extensive pastoralism. Appropriate tenure systems become much more tightly controlled, with private property rights becoming increasingly common. The model was developed to illustrate the production mix at which different forms of tenure are likely to make economic sense. It also indicates situations or 'zones' of conflict between herders and cultivators over access to resources for given levels of population density, macroeconomic conditions and technology.

Figure A5-1
Tenure Change in Agro-ecological Zones



Source: Swallow 1993