PN-ACM-085

Property rights, risk and livestock development

Summary of research results

Socio-economics and Policy Research Working Paper 29

ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE
International Livestock Research Institute
P.O. Box 30709, Nairobi, Kenya

IFPRI
International Food Policy Research Institute
2033 K Street, NW, Washington, DC 20006, USA

Göttingen Research Institute for Rural Development
Georg-August University, Busgenweg 2, D-37088
Göttingen, Göttingen, Germany

i

Working Papers Editorial Committee

Mohammad A. Jabbar (Editor)
Simeon K. Ehui
Steven J. Staal

LPAP working papers contain results of research done by ILRI scientists, consultants and collaborators. The author(s) alone is (are) responsible for the contents.

©2000 ILRI (International Livestock Research Institute)
All rights reserved. Parts of this document may be reproduced without express permission for non-commercial use but with acknowledgement to ILRI.

ISBN 92–9146–078–8

Correct citation: ILRI (International Livestock Research Institute). 2000. *Property rights, risk and livestock development. Summary of research results*. Socio-economics and Policy Research Working Paper 29. ILRI, Nairobi, Kenya, IFPRI (International Food Policy Research Institute), Washington, DC, USA, and GIRD (Göttingen Research Institute for Rural Development), Göttingen, Germany. 24 pp.

Table of Contents

Project staff iv
1 Introduction 1
2 Background to the study area 2
3 Theoretical models 4
3.1 The effect of production risk and management on the use of common pool rangelands 4
3.1.1 Policy implications 5
3.2 The effects of production risk on incentives to co-operate in rangeland management 6
3.2.1 Policy implications 6
3.3 Fuzzy property rights 7
3.3.1 Policy implications 9
3.4 The effect of drought mitigation measures on the use and management of common pool resources 10
3.5 The role of the state and donor agencies in influencing the management of common pool resources 11
4 Empirical evidence: Ethiopia and Niger 13
4.1 Ethiopia 13
4.2 Niger 15
4.3 Contrasting mobility patterns between Ethiopia and Niger 16
5 Conclusions 17
References 19

Project staff

Project staff members are drawn from the International Livestock Research Institute (ILRI), the International Food Policy Research Institute (IFPRI) and Göttingen Research Institute for Rural Development (GIRD) together with collaborators from Niger and Ethiopia. Students associated with the project are registered with York University (Canada) and Namur University (Belgium). The key personnel involved with the study are as follows:

Nancy McCarthy is a joint staff member of IFPRI, Washington, DC, USA, and ILRI, Nairobi, Kenya.

Brent Swallow served as project leader until September 1998, while at ILRI. He is currently at the International Centre for Research in Agroforestry (ICRAF), Nairobi, Kenya.

Peter Hazell is Director of the Environment and Production Technology Division of IFPRI, Washington, DC, USA.

Michael Kirk is a Professor at the Phillips-Marburg University, Institute for Co-operation in Developing Countries, Marburg, Germany.

Other project staff: Tim Williams (ILRI-Niger), Simeon Ehui (ILRI-Ethiopia), Winnie Luseno (ILRI-Kenya; currently at Cornell University, New York), Anna Knox-McCulloch (IFPRI-Washington), Boris Büchler (University of Göttingen), Serah Ikong'o (ILRI-Kenya).

Graduate fellows: Abdul Kamara (ILRI-Ethiopia and University of Göttingen) and Jean-Paul Vanderlinden (ILRI-Niger and York University).

Collaborators: Rachael Goodhue (University of California–Davis), Pierre Hiernaux (ILRI-Niger), Salvador Fernández-Rivera (ILRI-Ethiopia), Robert Lyons (University of California–Berkeley), Jean-Phillip Platteau (Namur University, Belgium), Layne Coppock (Utah State University), Chris Barret (Cornell University) and Solomon Desta (Utah State University).

1 Introduction

In this paper, we present a summary of research undertaken during the course of a project entitled 'Property rights, risk and livestock development'.[1] The goal of the project was to support appropriate reforms of property institutions and land policies in the semi-arid areas of sub-Saharan Africa.

The objectives were:

- to better understand how environmental risk affects the use and management of resources under alternative property rights regimes
- to identify circumstances under which different pathways of land use and property rights change are followed
- to identify how policy and other external interventions can assist communities to achieve desirable pathways and mitigate negative impacts of undesirable pathways.

We begin by giving a brief description of the environmental, institutional and economic conditions that characterise our study area. This is followed by a description of analytical and conceptual models developed to analyse the effect of environmental risk on use-levels, profits and welfare at the individual level, and on community and supra-community institutions governing property rights and land use. Next, we present empirical evidence from our study regions in Niger and Ethiopia, followed by concluding comments.

1. The project, which began in 1996 and ended in September 1999, was principally funded by the German Federal Ministry for Economic Cooperation and Development (BMZ). The project was a collaborative venture between the International Livestock Research Institute (ILRI), Nairobi, Kenya, the International Food Policy Research Institute (IFPRI), Washington, DC, USA, and the Göttingen Research Institute for Rural Development (GIRD), Göttingen, Germany.

2 Background to the study area

The drought-prone rangelands of sub-Saharan Africa support both livestock-keeping pastoralists and agropastoralists. Livestock production is of vital importance to the millions of impoverished people who live in these high-risk arid and semi-arid environments, and the flexibility and mobility of livestock are invaluable attributes. Livestock can be moved in response to variable rainfall conditions and can be purchased or sold in response to changing market conditions, thereby significantly contributing towards food security and household survival during difficult times, such as droughts. The rules that determine how resources—such as water and pasture—are used by the individual members of these competing pastoral and agropastoral communities are critical to their mutual survival and welfare in such environments.

After political independence in the 1960s, most African governments pursued the policy objectives of settling pastoral people, enhancing food self-sufficiency and increasing commercial offtake of livestock from the rangelands. Changes in property rights—often involving declarations of state ownership and registration of individual or group rights to particular plots of land—were undertaken in most countries. Implicit in the adoption of these policies was the belief that low productivity and degradation of the rangelands stemmed from a 'tragedy of the commons'. Problems with these policies are now widely recognised and most governments are now espousing revised policy objectives such as decentralised administration, empowerment of resource-user groups, food security and conflict management.

At the same time, the rangelands are coming under increasing pressure as human population growth results in ever more people depending on these arid and semi-arid areas: population growth rates in sub-Saharan Africa are amongst the highest in the world at around 4% per year. This pressure is imposing considerable stress on the traditional land management practices—tension that sometimes manifests itself as violent conflict between competing clans or tribes.

Property rights define the rules that govern who can use resources and how (Box 1). Unfortunately property rights are often poorly understood by many of those concerned with the process of development and intensification of livestock production systems in these areas: agricultural research organisations, extension services, development agencies and policy makers. A better understanding of property rights and how they are affected by environmental risk, such as drought, will allow appropriate policy interventions and institutional changes to be formulated. These changes can help direct the process of development and intensification of livestock production systems in the drought-prone areas of sub-Saharan Africa (and avoid the introduction of well-meant but harmful policies and interventions) whilst ensuring social equity and sustainability and mitigating undesirable negative impacts such as environmental degradation.

Box 1. Alternative property rights regimes

Traditionally, property is broadly classified as being **private, common, state** or **open-access.** There are many different definitions of these property rights in the literature. For this project, property rights represented a claim to a stream of benefits emanating from the use of a given resource such as an area of grassland.

Private property is simply assumed to represent the right to exclude others at the level of the individual, and to otherwise use the resource as desired (either under usufruct or freehold tenure). **Common property** is a claim to a specific resource by a specific group, where this group has authority to completely exclude non-members (though we also examine the case of partial access and use, and thus partial exclusion, as described below). **Open-access** implies that any one can freely use the property with no restrictions.

We make the further distinction that common property may be either **unmanaged, partially managed** or **perfectly managed.** In unmanaged common property, the group may exclude outsiders, but no restrictions and/or rules are required of members regarding the use of the resource held in common. Partially managed implies that members themselves must obey certain regulations, but that the regulations are not strong enough to ensure that socially optimal use-rates result. Perfect management results when socially optimal use-rates are achieved. The difference between common property and open access, then, is that common property necessarily entails exclusion of non-members; but neither necessarily entail any further use rules on those with access to the commons.

We also expand the concept of property rights to examine how access rights to resources in the pastoral environment can be either **complete** or **incomplete,** or **contingent** or **non-contingent.** Incomplete rights imply that one is not entitled to fully utilise a resource without restrictions or without limitation, while contingent rights means they are conditional on other, often external, factors. Taking the example of access to communal grazing land, if the users apply restrictions on how the grazing resource can be used and some of these restrictions vary, for example in relation to rainfall received, then they would be described as incomplete and contingent common property rights.

Not all those who are entitled to use the common resource necessarily enjoy equal access rights. In the case of access to communal grazing land, some clans or other sub-groups may have preferential claims—perhaps that clan whose home village is closest to that particular parcel of grazing land. These are often referred to as partial, or secondary, access rights.

3 Theoretical models

Many of the problems arising from the introduction of inappropriate policies in arid and semi-arid rangeland areas, discussed briefly in Chapter 2, stem from a lack of proper accounting for the temporal and spatial variability of rangeland production and the importance of mobility in sustaining livestock production in these environments. Rainfall varies across an extensive rangeland and this in turn affects the quality and quantity of pasture available in different parts of the range. It is therefore advantageous for livestock to be able to move to access those parts of the range offering the best grazing opportunities. While other researchers have considered the benefits of mobility across variable rangelands, none have previously examined the costs associated with the management of that mobility: the costs of inefficiency that would result from imperfect management or the cost of the management institution that governs access and use of rangelands. Also neglected until now has been the effect of production risk on how pastoralists use common pool rangelands.

Other major gaps in knowledge included analyses of the effects of broader-scale, or supra-community, policies and projects on the functioning of the agropastoralist system. A review of the literature[2] highlighted the fact that serious questions remain regarding the appropriate form that devolution of authority over natural resources should take. Also, whereas much of the work concentrates on the 'demand' side for institutions and institutional reform, gaps also existed in the knowledge of the factors affecting the 'supply' side of institutions.

A series of models has therefore been developed to explore the relationship between property rights, risk and policy on the decision making of African pastoralists. Crucially, these models evaluate the effects of temporal variability of the rangelands on pastoralists' behaviour and common property institutions. The different models focus on:

1. The effect of production risk and management on the use of common pool rangelands.
2. The effects of production risk on incentives to co-operate in rangeland management.
3. Fuzzy property rights.
4. The effect of drought mitigation measures on the use and management of common pool resources.
5. The role of the state and donor agencies in influencing the management of common pool resources.

3.1 The effect of production risk and management on the use of common pool rangelands

The model focuses on the pastoral household as a producing unit; it does not consider interactions between the production and consumption sides of the household. We

2. An annotated bibliography was undertaken by project members, and is published in Luseno et al. (1998). Extensive literature reviews can also be found in the proceedings of the international symposium on property rights, risk and livestock development (McCarthy et al. 1999).

assume that the pastoral household seeks to maximise the utility that they obtain from profits. Pastoralists are assumed to be averse to risk. The higher the profit the better, the lower the variability the better.

The rangeland situation that we have in mind may be best described by the non-equilibrial model: the density of livestock affects per animal growth in the current period but not in future periods. The rangeland is a common pool resource, access to the rangeland is fixed and the number of users is known. We consider the relatively simple case of two users. Extrapolation to larger numbers of users is possible, but the additional complexity does not change the nature of the results.

We consider two management regimes and two production risk situations. In scenario 1, the two livestock owners agree that they should jointly stock the number of livestock that will maximise joint profits (perfect co-operation) and there is no production risk. In scenario 2, the two livestock owners do not agree on the numbers that each should stock (non-co-operation) and there is no production risk. In scenario 3, the two livestock owners agree that they should jointly stock the number of livestock that will maximise the expected utility of profits (perfect co-operation) and there is production risk. And in scenario 4, the two livestock owners do not agree on the numbers that each should stock (non-co-operation) and there is production risk.

The outcomes in those four situations can be predicted by solving the optimisation and strategic interaction problems in each case. The following propositions follow from the first order conditions:

Hypothesis 1: The presence of production risk reduces the number of animals stocked under both management regimes. Under perfect co-operation, profits and expected utility decrease as production risk increases, whereas under non-co-operation expected utility will decrease, but profits may in fact increase.

Hypothesis 2: Aggregate livestock numbers are higher under non-co-operation than co-operation in both the risky and riskless cases.

Hypothesis 3: Aggregate livestock numbers under non-co-operation and production risk may be either higher or lower than under co-operation and no production risk.

3.1.1 Policy implications

Consideration of the implications of these propositions provides potentially useful insights into the risks associated with alternative interventions and policies. Overall, the model shows that increases in production risk, e.g. from dependable rainfall to highly variable rainfall, may reduce the overstocking that is caused by lack of effective co-operation in management. Conversely, reductions in risk, without effective management, can lead to overstocking, in terms of profit losses. These results highlight the need for care when designing drought mitigation measures. Interventions that reduce rainfall risk—such as emergency animal feed subsidies—may be attractive to individual livestock owners and reduce the risk that everyone dislikes. But, without effective management, those same interventions may have the unintended negative consequences of aggravating

problems of overstocking and a consequent decline in profits. This is bad enough if we consider only the current period, but it is even more worrying if we consider that such overstocking may cause deterioration in the quality of the rangelands in the future.

3.2 The effects of production risk on incentives to co-operate in rangeland management

Model 1 considered two extremes of management: non-co-operation and perfect co-operation. However, in real situations the level of management adopted is highly variable from one situation to the next. There are both costs and benefits associated with management and a rational individual will seek a level of management that maximises net benefits, i.e. the difference between the benefits and costs of management. So, recognising this, model 1 was extended to consider the incentives to co-operate. The magnitude of the incentives and the cost of co-operative management affect the amount of management a group will choose. Of special interest was the effect of production risk on the size of these benefits and costs.

The second model suggests several hypotheses concerning optimal levels of co-operation and risk:

Hypothesis 4: Groups of pastoralists who share common pool rangelands are likely to achieve levels of co-operation that are intermediate between no co-operation and perfect co-operation.

Hypothesis 5: The incentives to co-operate and deviate from co-operative arrangements are sensitive to changes in risk and economic parameters such as price and marginal cost. However, since the incentives all change in the same direction, the overall level of co-operation reached is relatively insensitive to changes in risk, price and marginal cost.

Hypothesis 6: For sufficiently large differences between pastoralists in terms of efficiency and/or risk preferences, no co-operative agreements will be sustainable and non-co-operation will result.

3.2.1 Policy implications

Partial co-operation in management of common rangelands is likely to be the norm. Perfect co-operation will usually be unrealistic. Not surprisingly, increases in co-operation will have the highest expected payoff when co-operation is near to zero and the lowest expected payoff when co-operation is near to perfect. The most direct ways to achieve increases in co-operation are through reductions in the cost of detecting deviation—that is cheating—and through facilitation of co-operation, e.g. through community-based training programmes. All else being equal, changes in profitability should have little effect on the level of management reached.

Also, it is important to aim productivity-enhancing or risk management programmes and projects at the poorer, less efficient producers, to reduce heterogeneity and thus improve the possibilities for sustainable co-operation. Failure to target productivity-enhancing interventions at the poorest pastoralists will have the effect of increasing the gap between the richer and poorer members of the community—the rich will get richer and the poor will get poorer, thereby reducing the possibility of achieving effective co-operative management of the common property resource represented by common pool rangelands.

3.3 Fuzzy property rights

Recent reassessments of rangeland ecology, the 'new range ecology' (Box 2), have resulted in a new appreciation of the way that pastoral systems cope with variability and

Box 2. The 'new range ecology'

Recognition that lack of proper accounting for the importance of temporal and spatial variability in rangeland production and the importance of mobility had sometimes resulted in the adoption of the wrong policies in these environments led to a new paradigm in the way rangelands were considered. Since the late 1980s many range ecologists and animal scientists have concentrated on the variability of rangelands, the resilience of rangeland ecosystems and the adaptability of pastoral societies. This led to a new school of thought now known as the 'new range ecology'. The tenets of the new range ecology are:

- that forage productivity is driven by climatic variables rather than stocking density
- that semi-arid rangelands are in fact resilient, not fragile
- that forage composition is patchy rather than evenly distributed spatially
- that an opportunistic, mobile grazing strategy is better suited to these environments than conservative, sedentary strategies.

The 'new range ecology' shed a great deal of light on the positive benefits of mobility for enhancing the pastoralist systems in the arid and semi-arid rangelands of sub-Saharan Africa, and in questioning how much range degradation actually occurred because of stock densities. Many of the researchers are range ecologists, and as such, tend to focus on the environment. Results from our research question the adequacy of the 'new range ecology' paradigm alone to analyse these systems, since animal productivity and thus producer welfare will be lower under improperly managed common property, *whether or not there are any long-term effects on range productivity*. Furthermore, in highly risky environments, the extent of overgrazing will change each year—and with imperfect management of the commons, the system will exhibit a greater variability, even if in some years (i.e. average), there is no evidence of overgrazing *per se*. Project managers, government policy makers and development specialists give weight to both producer welfare and the environment. For this reason, the 'new range ecology', which focuses mainly on impacts on forage productivity, may be misleading. Incorporating the insights and lessons from this body of research into an overall framework for assessing policy implications, however, is the key to better policy formulation.

change. Part of this coping mechanism is a property rights structure that does not fit neatly into the conventional categories of private, common, state or open-access rights.

The term 'fuzzy property rights' is a convenient label to describe this flexibly defined class of property rights. Fuzzy property rights may offer advantages compared to well-defined or 'crisp' grazing areas because of the following:

- the ability for pastoralists to improve their income by mutually adjusting access to common areas in response to rainfall conditions on other areas of their grazing ranges
- the ability to reduce risk through mobility.

The third model developed under the project therefore incorporates these important features using fuzzy set theory (Box 3). This model differs from the first two, which featured 'crisp' common property. Membership in these previous models was crisply defined: number of resource users, boundary of the resource and the availability of the resource at any time were well known to all members. This representation does not adequately capture characteristics of many African rangelands where in fact the boundaries of grazing areas and the membership of different user groups are rather imprecise. For example, some groups may use a pasture consistently from year to year but for different lengths of time. Other groups may use it only occasionally. Also, the use of the pasture may depend on the conditions in other parts of the grazing range. Fuzzy set theory is an appropriate approach to capture these conditions.

The model considers an area of pasture that can be accessed by two pastoral groups. Either group may or may not access the pasture during any particular period. There are fuzzy sets that define the degree of access of either group to the pasture. Neither group considers their access to be necessarily complete.

The fuzzy rights approach allows a number of propositions to be advanced:

Hypothesis 7: When both groups of pastoralists have the same degree of fuzzy access to a single patch of pasture, the total stocking rate will be the same as if they had both had complete crisp rights and did not co-operate in the management of the rangeland.

Hypothesis 8: When there are differences in the fuzzy access rights of two groups of pastoralists to a single patch of pasture, the total number of livestock will be lower than the rate that would prevail if they both had complete crisp rights and did not co-operate.

Hypothesis 9: Total expected returns to the use of the pasture will be higher under fuzzy rights than crisp ones under some relative access rights.

3.3.1 Policy implications

These results show that fuzzy property rights confer advantages over privatisation or crisp common property rights when fuzzy rights are relatively unevenly distributed. This may indeed mirror the situation in which clans maintain greater access rights to pastures near their settlements and lower access rights to pastures further from their settlements. The mutual recognition of lesser rights provides mutual insurance against fluctuations in

Box 3. Fuzzy sets

Fuzzy mathematics examines imprecise phenomena that lack clearly defined class criteria. Rather than a simple 0–1 definition of set membership, each object in a fuzzy set possesses a degree of membership in that set from the closed 0–1 interval. Standard sets are a special 'crisp' case of fuzzy sets, where every element of the set has a degree of membership of 1, and every element of its complement has a degree of membership of 0. A very simple example might be classifying a day as 'hot' or 'cold', or describing a year in terms of rainfall as being 'dry' or 'wet'. Some days may be described as being somewhat 'hot', or a year as being somewhat 'dry', but neither is adequately depicted as being 'hot' or 'dry', or alternatively, as belonging to the set of hot days or wet years with degree of membership equal to 1. Zadeh (1965) introduced fuzzy mathematics as a way of modelling extremely complex systems, where precise set definitions are either absent or extremely costly to model. Rather than requiring immense numbers of specific rules to define precisely the nature of a system, the use of fuzzy sets allows for imprecision in how each exact situation is described. Grazing rights in sub-Saharan Africa are defined in an extremely complex traditional system that is difficult to characterise fully. Factors such as kinship, other relationships such as age groups, relative shocks to primary grazing areas, and overall access rights to other areas all appear to affect access to specific areas. Rather than seek to precisely define all these relationships, which are site- and user-specific, we use fuzzy set theory to model the system and its consequences for users.

Fuzzy set theory describes the extent to which items possess a specific property, using the degree of membership. Essentially, fuzzy sets define the property by assigning linguistic variables to partitions of continuous values. Fuzzy sets gain descriptive power relative to classical, or crisp, sets because the partitions are not mutually exclusive. For example, in standard economic modelling, either a person has full access rights to a resource or no rights of access. In the case of private property, the owner has full access rights, and all others have access rights equal to zero; in the case of common property, members have access rights equal to one (full access), whereas non-members have no access rights. And yet, many situations regarding access to pastoral resources are described as having some pastoralists with full access, and other sub-groups who have partial access or secondary claims to these resources. It is precisely this phenomenon—where access can be described linguistically by degrees of access—that we attempt to capture with fuzzy set theory.

rainfall. Pastoralist groups may develop rules for adjustment of those rights depending on rainfall conditions that are actually realised.

Overall implications for policy of models 1–3

The high spatial and temporal variability of African rangelands means that there are clear benefits associated with mobility. Common property is often the social institution that supports that mobility. The possibility for sequential adjustment to rainfall conditions is the most important benefit of mobility. Conversely, common property can lead to the overuse of resources. This overuse will result in lower profits and may result in

long-term degradation of the range. The analysis presented for models 1 and 2, however, indicates that the overuse may not be a serious problem if:

- production risk is very high
- potential profits are very low
- the extent of heterogeneity is not large
- there really are no inter-temporal externalities
- the social institution that governs rangeland use is very effective.

Common property as normally conceived by researchers, i.e. crisp common property, is only one of the possible social mechanisms for facilitating mobility. Another would be exchangeable property rights. Formal exchange of property rights between communities and between communal areas and private ranches has been used in Zimbabwe to buffer the effects of drought. These arrangements should be given more consideration for other parts of Africa. A third type of mechanism would be fuzzy property rights. The requirement that there be asymmetry of those fuzzy rights, i.e. some groups have greater access rights than others, may well be the norm among traditional pastoral groups in Africa.

It is also important to consider the potential feedback effects between risk, pastoralists' responses and the management of the common rangelands. Interventions that are very well intended, and effectively implemented, may have many consequences that are not intended. A more holistic approach to drought risk and rangeland management may be necessary.

3.4 The effect of drought mitigation measures on the use and management of common pool resources

A conceptual framework for analysing the economics of intervention policies for drought management was also developed as part of the Property rights, risk and livestock development project. Based on a review of available evidence, the main conclusion is that once drought management interventions are institutionalised, they lead to changes in the way resources are managed, including increased cropping and privatisation of rangeland resources, and to more settled patterns of livestock production. These changes can contribute to greater productivity and improved livelihoods. However, if the interventions are subsidised, they can also lead to the adoption of excessively risky farm management practices, with increased losses in drought years and a growing dependence on government assistance.

Many drought management programmes also contribute to moral hazard problems because they reduce incentives for prudent management by farmers and herders. Drought management interventions need to be designed so that they assist farmers and herders to better manage risk and to improve their productivity and incomes, but without distorting incentives in inappropriate ways. The experience with the animal feed subsidy programmes in the West Asia and North Africa region and with restocking projects in sub-Saharan Africa have had mixed results. While they have helped protect

incomes and food security in drought years, they have had negative impacts on the way resources are managed.

Interventions that attempt to offset the negative effects of drought on livestock mortality may lead to large increases in the number of animals. The initial benefits to reduced mortality are then swamped by losses due to overstocking—unless these interventions are accompanied by other technologies to intensify production, and policies to strengthen the community's ability to continue managing their resources effectively in the face of changing individual incentives to co-operate.

Better alternatives could be area-based rainfall insurance, particularly if offered by the private sector, and the development of more accurate and accessible drought forecasting information.

3.5 The role of the state and donor agencies in influencing the management of common pool resources

Conceptual models have also been developed to examine the role of both the state and donor agencies in influencing the management of common pool resources. With regard to the state, review of the evidence shows that post-independence reforms aimed at the nationalisation of resources, the reallocation of property rights through agrarian reforms and privatisation of rangelands has led to state failure, institutional erosion and resource conflicts with regard to pastoralists' tenure regimes. In redefining the role of the state and rethinking the strengths and weaknesses of common property systems in the last decade, drafts for a comprehensive legal and institutional framework, decentralisation and conflict management have been developed. Conceptual frameworks resulting from applying 'new institutional economics' have led to four guiding principles in rethinking the state's role in pastoral systems:

- certainty in law
- that the rule of law includes respect for the constitution and human rights, a division of power as well as the strengthening of an independent judiciary and courts bound by law
- economic and political participation by those affected by changes in the land tenure system
- clear definition of property in a market-oriented economy.

However, it has also been recognised that traditional tenure systems do not, in general, rely on clear definitions of property, but rather rely on flexible arrangements of access. Thus, there is a need to integrate credible and effective legal instruments with traditional systems that often differ both in location and time.

Reviewing evidence from donor-supported rangeland projects and programmes leads us to conclude that such projects by these agencies focus too much on 'conflict-free' niches. In general, projects fail to address the urgent question of where and how to induce changes in existing property rights regimes at different levels, and only indirectly address the question of the form that devolution should take in a practical, policy-

oriented manner. Though the avowed aims are to devolve decisions regarding resource tenure and management to lower levels of government administrative agencies and to communities themselves and to develop a set of legal principles to allow for flexible arrangements regarding issues of tenure and access that differ across locations, practical guidelines and institutional and administrative capacities to implement effective reforms have led to a bottleneck in many devolution processes. Also, in most countries, the financial and human resources needed to reformulate the institutional environment have been largely underestimated.

Analyses of the roles of both state and donor agencies on the management of common resources show that a lack of an effective pastoralist 'voice' in both government and donor agenda-setting has led to ineffective land policies and/or stalled implementation processes. In practice, this is usually combined with a 'too narrow' perspective on common property resources, without embedding these property regimes into a broader spectrum including private or state property for specific key resources. Furthermore, clear definitions of the rights and duties of pastoralist associations or other collective action groups who participate, for example, in the demarcation and negotiation of boundaries and rules of access, are not yet developed.

4 Empirical evidence: Ethiopia and Niger

4.1 Ethiopia

The Ethiopian study is focused on the Borana Plateau in southern Ethiopia where the agropastoralist Borana people are the predominant ethnic group. The Boran rely on mobile herds of livestock and to a lesser extent, on crops. This area is semi-arid and the last major drought occurred in 1991–92.

Survey results reflect the consensus of many Borana people that the area of land being cropped is expanding dramatically. At the same time, private reserves for calves and milking herds have increased, at the expense of land dedicated to common pastures open either to the immediate community or to all Borans. This upsurge in private appropriation of land is largely due to recent changes in the system used to allocate cropland. Previously, local chiefs or community elders decided on land allocation issues. More recently, the presence and authority of peasant associations, managed by the Ministry of Agriculture, have increased. Some segments of the population, notably families with younger heads-of-households, now appeal to the peasant association rather than the traditional elders for private usufruct rights to plots of land, ostensibly for cropping, but sometimes used as private pasture enclosures.

Traditionally, land areas around permanent water sites, or *ardas*, have been designated for a variety of different land uses:

- *fora*—open access to all Borana people for grazing
- *warra*—open access to *arda* members only but with access granted to non-members for particular reasons or during some seasons only
- calf enclosures—also used for weak/sick animals, previously with access at the *arda* or sub-*arda* level but increasingly at the level of individual households
- reserve areas—open to *arda* members during the dry season
- cultivated land—allocated on usufruct basis.

Where cropping has become important, draft animal enclosures are increasing, with access granted at the sub-*arda* or household level. Thus, there seems to be an 'enclosure movement' occurring on the plateau with increasing areas of pasture becoming accessible only at the household level.

The survey conducted was designed predominantly to test predictions of the first two models discussed above, i.e. to test the effect of risk and other factors on the community co-operation and stocking rates. Preliminary results from the analysis of Ethiopian data are as follows:

Factors that increased stocking density included:

- higher price of livestock
- greater range productivity index
- higher *arda* population and greater heterogeneity of the population (in terms of a wealth ranking given by community leaders; largely determined by heterogeneity in livestock holdings).

Factors that reduced stocking densities included:

- higher variability of rainfall
- greater composite index of co-operation
- greater distance to market.

While factors that had no impact on stocking density included:

- distance to veterinary services
- price of crops.

Factors that led to an increase in the index of co-operation included:

- higher variability of rainfall
- whether members regularly migrate to outside pastures
- higher range condition score.

Factors that led to a decrease in the index of co-operation included:

- greater number of households
- greater degree of heterogeneity in wealth among members
- greater distance to market
- whether outsiders regularly come into the *arda* to use its pastures.

Relative livestock prices had no impact on the index of co-operation.

The results of our Borana survey largely support the hypotheses of the first two models. Particularly important is the negative effect of increased rainfall variability on stocking rates and the positive effect of rainfall variability on the index of co-operation. Together, these results imply that high rainfall variability will have a negative effect on stock densities, both directly and indirectly through the impact on co-operation (higher rainfall variability positively affects the index of co-operation which then has a negative effect on stock densities). Conversely, lowering environmental risk (i.e. through drought-relief programmes) may inadvertently lead to higher stock levels, and potentially, to much lower incomes.

Furthermore, land allocated to crops increases as population density and bush encroachment increase, and decreases with the index of co-operation and as distance to markets increases. Thus, it appears that current changes in land use patterns are, at least in part, a function of the desire of individuals to diminish the negative externalities associated with overstocking on the commons. One of the key driving forces seems to be increased population and increased heterogeneity among community members; increased privatisation of land is also more likely in areas with lower coefficients of variation and where non-community members more frequently migrate into the community. However, population density *per se* has an ambiguous effect on the ability of the group to co-operate—co-operation appears to be more difficult at very low and very high densities, but is positively associated with co-operation at the mid-level densities that prevail in most communities. On the other hand, the Boran are becoming more settled and some land use change is a function of relative prices favouring crops and the availability of subsidised inputs from the Ministry of Agriculture. Nonetheless, co-operation can mitigate negative externalities on the commons and thus the incentives individuals have for over-allocating land to crops and private pastures. One of the key

elements in fostering co-operation will be methods for handling the increased heterogeneity among community members and managing the negative effects of increased wage work on co-operation. Whereas currently members dedicate primarily time to community activities, monetary payments based on wealth levels may help to alleviate the negative effects of both heterogeneity and increased wage work.

Finally, drought management programmes will have to be assessed in terms of their impact on stock densities and land allocation. Low stock densities and less crop and private pasture land are associated with high rainfall variability; programmes that alleviate the effects of the downside risk may increase to both stock levels and private land over and above the social optimum.

4.2 Niger

Population growth in Niger is leading to an expansion of cropland at the expense of traditional pastures. The shift from pastoralism to more settled farming is driven in part by increasing population pressure and greater commercialisation of agriculture. These forces create new opportunities and new needs for intensifying the farming system. At the same time, these forces can also lead to greater enclosure and settlement of traditional grazing areas, leading to diminished access rights to these areas. Thus, the decline in traditional pastoralism can be seen as a cause as well as a result of diminishing access to transhumant grazing areas, and to a shift to increased cropping.

To better understand the economic forces driving these transformations, and to assess their implications for future livelihoods and environmental sustainability, a bio-economic model was developed and applied to a typical community in the semi-arid areas of Niger. The model is used to simulate the longer-term consequences of changes in population growth and reduced access rights to transhumant grazing areas. Particular attention is given to the role of drought risk in conditioning the model's results and how improved methods of managing drought risk affect the development pathway that the community follows.

Simulation results show that transhumance significantly helps to maintain the size of the village livestock herd and to reducing herd losses in drought years. If the village were to lose all its traditional access rights to grazing areas then the impact on livestock production would be severe. However, transhumance does not have a big impact on per capita incomes. This is partly because livestock income is only a small part of total income (crop income and earnings from seasonal migration for non-farm employment during the dry season are much more important). Also, because the village would in turn exclude others from using its own grazing resources, this would increase the availability of local pastures and crop by-products for the animals owned by members of this village.

Supporting the hypotheses regarding the impact of reduced production risk on livestock numbers, simulation results show that if the villagers were able to purchase supplementary feeds for their livestock, then this could lead to a dramatic increase in the herd size. Though this would reduce the loss and sale of animals in drought years, mean incomes might still be reduced due to overstocking and consequent pasture degradation.

Use of purchased feeds would also significantly reduce the need for transhumance. But again, the impact on per capita incomes would be modest because livestock income is only a small part of total income in this particular village.

4.3 Contrasting mobility patterns between Ethiopia and Niger

There are major differences in the mobility patterns practised by the agropastoralists in the two project field sites, Ethiopia and Niger. On the Borana Plateau of Ethiopia pastoralists remain in the home area during the wet season and migrate to more distant pastures in the dry season. This is possible because the area of land being cropped is not sufficiently large to necessitate that livestock be moved during the growing season to avoid crop damage and also because the crops tend to be protected by thorn fences. In Niger, on the contrary, livestock migrate to distant pastures in the wet season and remain in the home area during the dry season. Here, croplands are unfenced and animal owners are largely responsible for crop damage caused by their stock.

Comparative analyses of these two sites suggest that it will be more difficult for communities in Niger to co-operate and manage pasture resources sustainably because home areas are used predominantly in the dry season; whereas co-operation will be easier to sustain during the wet season when resources are more productive. Also, in Niger where most weight gain and improvement in the animals' condition occurs on distant pastures then the livestock keepers simply need to keep their animals alive during the dry season. In this situation it may be rational to use the home resource as a 'sacrifice area'—i.e. to use it at any cost—irrespective of whether land is under private or common tenure. Practical measures to improve co-operation are likely to fail. Efforts would be better directed towards promoting cost-effective technologies and techniques to offset dry season losses, such as use of crop residues, industrial by-products or bought-in feed. These inputs, however, should not be subsidised, as this would result in unsustainably high stock levels and potentially to long-term degradation of the home pasture. In contrast, efforts at improving co-operation in Ethiopia are much more likely to lead to desired results. These efforts should concentrate on reducing the unit costs of co-operation—i.e. decreasing monitoring and enforcement costs and increasing 'social capital'—and on directly reconciling conflicting interests among producers.

5 Conclusions

The models and empirical research presented in this paper clarify one of the contradictions mentioned in the introduction. The high spatial and temporal variability of African rangelands means that there are clear benefits associated with mobility and common property is often the social institution that supports that mobility. However, common property can lead to the overuse of resources. This overuse will result in lower profits and may result in deterioration of the range. For given policies of governments and donors, results of this research indicate that overuse of natural resources may not be a serious problem if production risk is very high, the extent of heterogeneity in terms of wealth or productivity is not large, if the community is neither 'too' small nor 'too' large, if future pasture productivity does not depend on current stock levels, or if the social institution that governs rangeland use is very effective.

Second, common property—characterised by fixed boundaries and membership—as normally conceived by researchers is only one of the possible social mechanisms for facilitating mobility. Another possible mechanism is fuzzy property rights. This type of flexible rights system will be preferred to a 'crisp' common property when fuzzy access rights are relatively heterogeneous, but herders are relatively homogenous in terms of wealth levels and productivity. This situation may well be the norm among traditional pastoral groups in Africa. However, if heterogeneity among producers increases, and government policies actively promote equal access that inadvertently leads to open access situations, more 'crisply' defined property rights may in fact lead to improved incomes and welfare of the pastoralists.

Third, it is important to consider the potential feedback effects between risk, pastoralists' responses and the management of common rangelands. Well-intended interventions effectively implemented may have harmful and unintended consequences. For example, feed subsidy programmes that offset the negative effects of drought may in turn lead to overstocking, lower profits and higher government outlays than originally foreseen due to moral hazard and greater mismanagement of common property resources. Another example is given by programmes and policies intended to clarify property rights, with the intended goals of assuring access across different groups (equity in access) and of promoting investment in maintenance and management of the common property resources. These rights may instead encourage private appropriation through 'land grabbing', or alternatively, to a *de facto* open access situation.

Fourth, while anecdotal evidence supports the hypothesis that flexibly defined, or imprecise, access rights may increase average incomes and reduce variability, these access rights are currently enforced by traditional institutions. They are not proscribed in law or enforced by the state. Given population growth, expansion of cropland and the concomitant increased scarcity of land resources, conflicts are likely to become an ever-larger problem. Keeping a flexible access system and avoiding constant conflicts will require a legal structure that is itself flexible but not excessively costly. Devolution of authority may be one mechanism for managing community-level resources and the differential access to those resources. However, one cannot underestimate the costs involved

in constructing and maintaining such a system, which will require understanding the complex structure of claims over resources and thus express participation of community members themselves. Yet while investment in community management may be costly initially and not bear returns for some time, once in place, it is likely to contribute substantially to resource management while at the same time preventing both inefficiencies and inequities that arise from speculative privatisation of land.

Finally, we note that though many of the hypotheses of the conceptual and analytical models are supported anecdotally, there remains a dearth of empirical data with which to test these hypotheses. While initial results from the empirical data analyses in Ethiopia and Niger support some of the more contentious hypotheses developed, the scope of the data collection activities was insufficiently broad to generalise results beyond those areas, except with extreme caution. This is important to emphasise now since many countries that are signatories of the United Nations Convention to Combat Desertification are in the process of developing drought mitigation strategies and policies. The fact remains, however, that two paradigms in rangeland development theory are contrary. One supports the idea that decreased production risk will lead to lower stock levels, higher incomes and higher welfare, while the other posits that decreasing downside risk alone will result in unsustainably high stock levels (as long as the programme remains in place) and lower incomes. These contrasting hypotheses—and their implications for development programmes in the drought-prone rangelands of sub-Saharan Africa—require further empirical testing. The survival and welfare of Africa's pastoral and agropastoral communities may depend on our getting this hypothesis right.

References

Luseno W., Swallow B., Vanderlinden J-P, Williams T.O., McCarthy N., Kirk M. and. Kamara A. 1998. *Property rights, risk and livestock development–An annotated bibliography.* ILRI (International Livestock Research Institute), Nairobi, Kenya. (Mimeo). [Requests for copies should be addressed to: N. McCarthy, IFPRI, 2033 K Street, NW, Washington, DC 20006 or via email to: n.mccarthy@cgiar.org].

McCarthy N., Swallow B., Kirk M. and Hazell P. (eds). 1999. *Property rights, risk and livestock development in Africa.* IFPRI (International Food Policy Research Institute), Washington, DC, USA. 433 pp.

Zadeh L. 1965. Fuzzy sets. *Information and control* 8:338–353.