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SYNTHESIS PAPER

WHY INVEST IN DRYLANDS?

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WHY INVEST IN DRYLANDS?

Executive Summary

This paper argues a case for investment (both public and private) in drylands, with a focus on Africa, where assessments have been most negative. This case rests on new evidence of long-term success stories achieved by small producers, and a re-evaluation of key trends. A new paradigm of dryland development is proposed. The priorities for policy formation, by governments, donors and international agencies, are suggested.

Why the drylands matter (Section 2). There are four compelling reasons why the drylands matter in the global debate about sustainable development. First, they contain large populations living at low levels of poverty. These numbers of poor people are so large that they threaten to block the achievement of the Millenium Development Goals (MDGs). Second, their capacity to contribute to food security, both at local and at national levels, is considered by many to be under threat. Third, natural resources and ecosystems, according to many data, are degrading ('desertification'). Finally, many development investments have failed to reverse the observed trends, creating an urgent dilemma for policy: whether to continue 'business as usual' or to find new approaches. The Sections which follow take up each of these questions in turn.

More people, more poverty? Success stories (Section 3). Experience from studies at the district level challenges the link normally made between drylands and deepening poverty. The first is in Machakos and Makueni Districts, Kenya. A six-fold increase in the value of output per km^2 was achieved, over nearly 60 years (1930-1987), and a doubling in the value of output per capita, even while the population grew at an annual rate of up to 3.1%. Yet rather than degradation, an impressive improvement in soil and water conservation was accomplished, much of it by the efforts of the farmers themselves. The second is in Burkina Faso, where rainfall declined and population increased from the 1960s. In the Central Plateau, grain yields per ha, and soil conservation, both increased significantly over two decades (1980s-1990s). In the Eastern Region, average grain yields increased by 400 kg ha^{-1} after 1980, and production per capita doubled. The third is the Kano Close-Settled Zone in northern Nigeria. There, the highest rural dryland population densities in Africa are found. Yet a labour-intensive form of agriculture sustained yields per ha, and conserved the soil, for more than 100 years. This study also confirmed the crucial role played by urban food commodity markets. Other studies identified 'incipient success.' In Maradi Department, Niger, severe degradation, with a crisis in the production system, was diagnosed after the Sahel Drought of the 1970s. Yet instead of expected decline, average grain production per caput was maintained, above the nutritional requirement of a rapidly growing population (1979-2001). There are signs of a transition beginning towards more sustainable land use practices. In Diourbel Region, Senegal, farmers adapted to the collapse of the state-controlled agrarian system by diversifying into livestock and new crops. They also re-allocated their capital resources outside agriculture, where returns were sometimes better.

Food security endangered? Evidence of resilience (Section 4). The foregoing 'success stories' are documented at the district level. But even at national level, there are reasons for questioning the commonly expressed view that the agricultural sector has failed in Africa. The long-term agricultural data (1960-2001) provided by the FAO, for three West African countries with large dryland regions (Nigeria, Senegal and Mali), shows that the truth is more complex, and varies from country to country. These long-term dynamics show responsiveness on the part of small family farms and livestock enterprises to market signals. This is why several *export* crops, affected by global prices, have declined or been diverted to domestic markets. Supply constraints, even in the drylands, were less critical for *food* production than sometimes supposed. The 'new' cereals (rice, maize), and livestock, were most responsive, while the 'old' cereals (millet, sorghum) were less so. Nevertheless, except in Senegal (where the government intervened to promote the use of imported rice), production of the 'old' cereals per caput was stable in the long term. The data suggest that producers are responsive to incentives, whose improvement should be an aim of new policy.

Drylands degrading? Reversing the trends (Section 5). Recent analysis of earth satellite data shows an unexpected 'greening of the Sahel', which means a trend of increasing values for the vegetation index between 1982 and 1999, probably continuing through 2003. The trend is statistically significant.

The process responsible, however, is not adequately understood. There appears to be some correlation with rainfall, but taken alone, this explanation is not sufficient. Land use changes appear to be involved. Policy makers have long regarded deforestation as a major threat. However, data from many studies show that farmers value, plant and protect trees, especially on farmland. Cutting for fuel has been exaggerated. Dry woodlands are more productive than formerly thought. Another controversial theme is soil fertility (and in particular, carbon) management. Whereas global data have been used to show severe losses in plant nutrients, and to justify interventions on a large scale, studies show that farmers invest in more sustainable practices, which also facilitate carbon sequestration. These studies suggest that the drylands, rather than being a 'development sink', requiring urgent and costly rescue from destruction, may yet offer acceptable returns on investment. They may even make a contribution to global climate improvement as land use practice intensifies. Reversing the degradational trends is, of course, a condition for securing and improving ecosystem goods and services, including agricultural productivity. The new evidence suggests that this is beginning to take place.

Public investments failing? Evidence of favourable returns (Section 6). New Indian evidence shows that public sector investments in dry and sub-humid rainfed areas may give a superior return to those in humid or irrigated regions. This finding is not directly applicable to Africa, owing to differences in stages of development. But analyses of five donor-supported projects in Africa (soil and water conservation, irrigation rehabilitation, forestry management, agricultural extension and market development) lead to the conclusion that economic rates of return can be favourable in African drylands too. Where financial data are not available, evidence of strong adoption shows success.

Private investment unaffordable? Incentives work (Section 7). Private investment by small farmers and livestock producers is the key to sustainable management of drylands, which is too large a challenge for the state or donors alone. Small producers invest in small-scale, incremental and long-term strategies often overlooked by outsiders. They invest in order to construct secure livelihoods in which agriculture is by no means the only source of income. A range of indirect incentives is available to policy makers to promote such investments. *Enabling* measures (such as institutional changes) and *variable* incentives (like input and output prices) determine the profitability of an enterprise. Unless public sector investment stimulates private investment, and of small producers in particular, development is not sustained. In drylands, risk imperils private investment. But the 'success stories' show that there is a capacity to invest, given incentives.

Policy inaction inevitable? The cost of doing nothing (Section 8). The high costs of a 'business as usual' strategy are illustrated with provisional data from **China** and Ethiopia. The database for such an evaluation is still weak, but the orders of magnitude of these estimates give good cause for concern. In China, the direct costs have been estimated at US$7.7 billion (4% of GDP), and indirect costs at US$31 billion. In Ethiopia, yearly losses of nutrients from agricultural areas have been estimated at US$106 million, of forest at US$23 million, and of livestock capacity at US$10 million, in all US$139 or 3% of agricultural GDP. The price of inaction will ultimately be paid in lost production, reduced value of natural capital, reduced food security, increased poverty and the costs of welfare and emergencies. Governments (and the donors who support them) cannot afford inaction. Proactive investment and policy are a much superior long-term strategy, for if the costs of neglect are huge, so are the potential benefits of action.

A new paradigm for dryland development (Section 9). A new policy landscape is emerging. 'People-centred development' reverses the priorities from 'top-down' technical solutions to releasing human resources. Small-scale resource managers need support in their efforts to create sustainable dryland production systems. There is still a role for technology. But rather than universally applicable new or 'miracle' technologies, the small producers of the drylands need a diversity of site- or enterprise-specific solutions from which they can choose according to individual circumstances, and which they can adapt in light of their own experience and knowledge. The agenda is thus shifting for development agencies, research institutions, governments and donors. Some drylands have made impressive progress despite severe constraints. It should be the role of the public sector to (1) relax these constraints, (2) improve the incentives for investment, and (3) facilitate scaling-up the successes.

The case for investing in drylands rests, therefore, in (1) the size and population of drylands; (2) the achievements observed in the 'success stories', (3) evidence that agricultural systems are resilient; (4) that degradation is not inevitable; (5) that public investments can and do pay; (6) that policy incentives (to invest) do work; and (7) that the costs of neglect and the benefits of action are potentially huge.

1. Introduction

A case is made in this paper for investing in tropical and sub-tropical drylands, in poor or middle-income countries. These environments, their people, and their production systems have long been regarded as risky investments. This is because rural people in drylands face many challenges:

- *Low agricultural productivity* is caused by low rainfall, high evaporation and infertile soils.[1]
- *Droughts* are frequent and unpredictable, so there are large fluctuations in yields and in household incomes from year to year.
- *Poverty* is endemic, and often made worse by distance from markets, health and education services, and safe water.
- *Linkages with cities or more humid areas* are vitally important as most dryland peoples need to sell their labour or services, trade or graze their animals there.

In poor countries generally, productivity gains in *agriculture* are considered by many to be a condition of broad-based economic growth, because:

- about 70% of the world's poor still live in rural areas;
- agriculture provides employment for two-thirds of working Africans and 60% of Asians, and generates a third of Africa's Gross National Income and 27% of Asia's;
- where economic growth is fastest, agricultural productivity has risen the most;
- no other economic activity benefits the poor so much;
- efficient agricultural production provides food at a low cost to non-agricultural consumers.[2]

The case for *drylands* differs in two respects. First, the drylands face special challenges that are not generally shared in more humid regions. Second, they have fallen behind more favoured environments in agricultural, economic and social development. There is a risk that the gap will widen in future.

But assessments are changing, and new evidence supports the premise that 'there are important and significant populations in the world's drylands who, given the right conditions and incentives, can achieve good livelihoods, accumulate assets to reduce vulnerability, and escape from poverty'.[3] Africa should be no exception to this. However, among the continents, the African drylands receive the most pessimistic assessments.[4] Because Africa faces the greatest challenge in dryland development, therefore, it is the focus of this paper.

The case for investment (both public and private) is set out as follows. In Section 2, some reasons are given why the drylands matter in global development. These issues have often been represented in terms of crisis scenarios, and may be abbreviated in the following questions, which will be answered in Sections 3 - 8:

- More people, more poverty? *Section 3*
- Food security endangered? *Section 4*
- Dryland ecosystems degrading? *Section 5*
- Public investments failing? *Section 6*
- Private investments unaffordable? *Section 7*
- Policy inaction inevitable? *Section 8*

In Section 9, the new policy landscape is analysed and priorities suggested.

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[1] The term 'agriculture' is taken here to include both crop and livestock husbandry.

[2] DFID (2003) *Agriculture and poverty reduction: unlocking the potential. A DFID policy paper.* London: Department for International Development.

[3] P.Dobie (2001) *Poverty and the drylands:* 2. Nairobi: UNDP Drylands Development Centre.

[4] UNEP (1992) *World Atlas of Desertification.* Nairobi: United Nations Environment Programme.

2. Why the Drylands Matter in Global Development

The world's drylands have a bad press in development debates. In this section, the reasons for this are summarised, as a launching pad for the new perspective which is argued in the subsequent sections.

More people, more poverty?

Excluding the deserts, polar or mountain regions, and major cities, the drylands contain 1.2 billion or a fifth of the world's population (perhaps 200 million households). Rates of population growth have often exceeded 3%/yr for long periods. Cultivable land is now scarce, and holdings are getting rapidly smaller.

Dryland people are more likely to be poor, in comparison with more favoured regions, where trends in standard indicators are more encouraging. For example, in Africa:[5]

- In Kenya, the highest incidence of poverty is in its northern arid and semi-arid districts, and life expectancy, adult literacy, secondary school enrolment and the Human Development Index are lower than in Nairobi;
- In Cameroon, although 31% of its people live in the semi-arid Northern Region, 50% of the country's poorest people are found there, with the highest rates of illiteracy, poor housing and maternal mortality.

Within the drylands are found many disadvantaged groups, such as female-headed households, land-poor farmers, and pastoralists. Progress towards the MDGs is slower in Africa than in Asia, and slower in drylands than in more favoured environments. Based on their *needs*, dryland people deserve more attention in development policy. Based on their *right* to participate fully in human development, they have a strong claim to more assistance. Based on the global commitment to the MDGs, the numbers of poor people in drylands, unless reduced, will threaten the achievement of those global goals.

Box 1: What are the 'drylands'?

The tropical and sub-tropical drylands are divided into three zones, based on the moisture (or aridity) index. The index P/PET (precipitation over potential evapo-transpiration) measures the relationship between annual rainfall and the loss of water to evaporation, either directly or through plants.

Arid	0.05-0.20
Semi-arid	0.20-0.50
Dry sub-humid	0.50-0.65

These three zones correspond to a range in the average length of the growing period from >75 days in the arid zone to a maximum of about 180 days in the dry sub-humid zone. Variability does not feature in this typology, which is based on mean values. Rainfall in the African Sahel declined from the late 1960s to the 1990s. In other drylands, rainfall data suggest long-term cycles.

Drylands so defined cover 40% of the earth's land surface, occur on every continent, and provide homes for 38% of the world's population. Of Africa (excluding the deserts), 43% is dryland.

Source: World Atlas of Desertification (First Edn., 1990). Nairobi: United Nations Environment Programme

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Food security endangered?

The contributions made by drylands to local and national food security appear to be under threat from stagnating or declining productivity. Rural dryland households try to produce as much of their own food as possible, or else obtain it by selling crops or livestock products. Great distress occurs when

[5] P.Dobie, *Poverty and the drylands, op.cit;* P.Hazell (2001) *Agricultural research and poverty reduction. Food, Agriculture and the Environment Discussion Paper 34:* 7. Washington,D.C.:International Food Policy Research Institute.

drought reduces this productive capability. Small producers seek to achieve food security and prefer not to risk being over-dependent on markets. Crops, livestock and fish from drylands also feed urban populations. As cities grow, the market demand for staple food grains and for higher value foods (such as meat, fish, cowpeas) increases.

Unless technical change is achieved, major threats to dryland agriculture can be discerned, which may adversely affect food security at a national level. First, stagnating or declining crop yields, caused by soil degradation or by rainfall decline, may reduce productivity. In the past, declining yields could be compensated by expanding the cultivated area, but this is now ceasing to be possible, as productive land is becoming scarce. Second, livestock production may be adversely affected by falling productivity in the natural rangelands. These are declining in size as more land is taken up for farming, increasing the risk of overuse. Third, resident rural populations are still growing, and they need to assure their own food security, as well as supplying markets. However, intensification is slow or patchy. A failure in dryland agriculture will have adverse effects on the economy, increasing balance of trade deficits, donor dependency, urban migration of poor people, and the costs of service provision and welfare.

Dryland ecosystems degrading?

Both the productivity and the sustainability of dryland ecosystems are threatened by degradation processes collectively known as *desertification* (Box 2). These include: erosion by water or by wind; increased surface runoff after rain, reduced infiltration, and declining water tables; soil degradation, or the loss of fertility; deforestation or the destruction of natural vegetation; and the loss of biodiversity. [6] A loss of economic productivity will weaken livelihoods directly. A loss of 'ecosystem goods and services' (such as reduced biodiversity, forest and wild habitats, rainfall infiltration and groundwater recharge) undermines the functioning and integrity, and therefore the future sustainability of the natural ecosystems. Human management is thus assumed to be critical, though the impact of climate change is also acknowledged.

The impact of desertification is suggested by estimates such as those following, which are based on global surveys:[7]

- About 40% of the earth's land surface is dryland (arid, semi-arid or dry sub-humid), and in Africa 56%, all of which is susceptible to degradation.
- About one billion hectares, or 20% of the global extent of susceptible dryland soils, are being degraded by human activity. In Africa, the fraction is 25%.
- About 467 million hectares, or 9% of the global extent of susceptible dryland soils, are being degraded by water erosion. In Africa, the fraction is 9%.
- About 432 million hectares, or 8% the global extent of susceptible dryland soils, are being degraded by wind erosion. In Africa, the fraction is 12%.
- There is a strong correlation between a high severity of soil degradation and low values on the index of vegetation, which highlights the exposure of the drylands, in comparison with more vegetated and humid areas.
- In Africa, all but three of 38 countries are said to be losing more than 30 kg/ha of the key soil nutrients: nitrogen, phosphorus and potassium.[8]
- In West Africa, net rates of forest loss in dryland countries vary from 0.2 to 3.7%/yr.[9]

All estimates of dryland degradation depend on uncertain data. This uncertainty is sometimes ignored in the interpretations put on them.

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[6] Bonkoungou, E.G. (2002) *Biodiversity in drylands: challenges and opportunities for conservation and sustainable use.* Nairobi: UNDP Drylands Development Centre.

[7] *World Atlas of Desertification* (First Edn, 1992) Nairobi: United Nations Environment Programme.

[8] *Sustainable development in a dynamic world. World Development Report, 2003*. Washington, D.C.: the World Bank.

[9] *Global forest resources assessment, 2000. Main Report:*116. Rome: FAO, 2001.

Box 2: What is desertification?

The definition used by the UN Convention to Combat Desertification is as follows:

> Desertification means land degradation in arid, semi-arid and sub-humid areas resulting from various factors, including climatic variations and human activities.

The adoption of this definition did not resolve many contentious issues which were reflected in earlier definitions, especially the priority (or not) of human agency, and the time-scale of the resulting changes (termed 'desertification' if they are not easily or quickly reversible).

The UN Conference on Desertification (1977) approved a Plan of Action to Combat Desertification, which was largely unsuccessful owing to a failure to attract donor support on the scale necessary for its ambitious activities. Facilitation of national activities under the terms of UNCOD was the responsibility of the Desertification Branch of UNEP (in Nairobi) and its Clearing House Mechanism. The National Action Plans now prepared under the terms of the UNCCD are the primary responsibility of the countries, the Global Mechanism of the UNCCD (in Rome) mobilises funding, and the Convention Secretariat (in Bonn) serves the Convention. Other global institutions (UNEP, GEF, IFAD, CGIAR) are involved in partnerships which explicitly target desertification.

Public investments failing?

Many development projects and programmes have often given poor returns on investment, or proved unsustainable for technical, managerial or economic reasons. Development assistance to the agricultural sector has fallen, states are short of funds, and it is clear that new thinking and strategies are required. Taking a long historical view, the following examples illustrate the breadth of this failure:

- *Senegal: the collapse of the Programme National Agricole.* The groundnut-producing region or 'peanut basin' in dryland Senegal enjoyed nearly a century of public investments in transport and marketing infrastructure. The state took a monopolist role in credit, input and equipment supply, technical advice, marketing and processing. It also controlled the internal trade in grains, and supplied imported rice. But the government was forced by the deterioration of its finances to withdraw many of its services from 1983-85. Seed and subsidised inorganic fertilizers on credit were affected. The sudden withdrawal of support resulted in an abrupt fall in groundnut production, and the reduced prices led to a diversion of output from the state oil mills to local markets. Farm capital was reported being sold. Fertilization slumped, and agricultural intensification faltered.
- *Nigeria: irrigation in the Lake Chad Basin.* During the 1960s and 1970s, irrigation projects were developed, based on the water resources of the Yobe River and of the Lake itself, and driven by a policy of import substitution (mainly of wheat). But high development costs, remoteness from markets, poor yields (affected in some places by soil salinity), and ultimately, reduced river flow and the disappearance of the Lake from Nigerian territory, led to the demise of these large schemes. However, small-scale irrigation, mainly using private capital, prospers along the banks of the Yobe.
- *Niger: well provision in the pastoral zone.* Large-scale sinking of government wells and boreholes was carried out during the 1960s. They opened up areas of grazing which had previously been difficult to use during the dry season, owing to a lack of surface water. Unlike the wells managed collectively by pastoral groups in the area, these became open access sources and stimulated a rapid growth in livestock numbers. Notwithstanding the income benefits they brought, risks of overgrazing and of conflict with farming communities increased.
- *Nigeria: arid zone afforestation.* Nigeria embarked on extensive afforestation programmes in the states along its northern border during the 1970s. However, high costs were incurred in establishing nurseries in remote locations, acquiring land for shelter belts, fencing, and promoting on-farm tree planting. Most of the shelter belts suffered from low survival rates and incursions from livestock, and the millions of seedlings distributed to farmers met with a sceptical reception. Late planting, low rainfall, poor tending and inadequate protection from livestock were the results. Little lasting evidence can now be seen of this programme.

Low financial rates of return, financial unsustainability, unsatisfactory uptake or impact, unforeseen consequences, and mismanagement contributed to poor project performance. Recent projects have attempted to correct such mistakes, but it is not surprising that a negative stereotype is widely held of dryland development potentials.

Public resources were invested instead in areas of high potential, where intensification was expected to bring greater improvements, and new technologies greater scope. However, treating drylands as 'development sinks' may ultimately incur high costs in lost production, welfare provision, and social instability.

Private investment unaffordable?
Another widely held view is that poverty inhibits private investment by small producers, and therefore compels a short-term approach to natural resource management. Woodland is cut down, or cultivation extended onto 'fragile' soils, with other forms of 'mining natural capital'. As conservation was regarded as a precondition for improved productivity, so public sector investment often concentrated on technical interventions, which were driven by expert diagnoses, and were sometimes coercive. Such agendas did not necessarily correspond with the peoples' priorities, neither were they necessarily financially viable.

Negative stereotypes of small producers' incapacity or unwillingness to invest distracted outsiders' attention from the nature of investments in natural resource management, and the kinds of incentives required. *Not* discounting the future is, after all, a condition for a sustainable livelihood.

Policy inaction inevitable?
An inability to assess the true costs of ecosystem degradation has stood in the way of macro-economic policies for natural resource management, based on economic analysis. Instead, piecemeal and sectoral approaches to localised hazards, such as preventing soil erosion on steep slopes, have been characteristic. Paradoxically, such approaches tend to direct public resources to projects that are least likely to yield satisfactory returns on investment. It is not surprising that there should be resistance to sending more funds this way, even as public resources become scarcer.

On the other hand, the same economic analyses can demonstrate the likely benefits of controlling degradation, and point to appropriate policies that transfer some of the responsibility from an over-taxed state to private investors.

A new paradigm of dryland development
Major dilemmas, therefore, face public policy with regard to investing in drylands. The degradation model continues to speak loudly to planners, but is there an alternative approach? This paper argues that there is such an approach, and sets out its essentials (Section 9).

3. More People, More Poverty? Success Stories

Perceptions of degradation have been influential in driving development policies in drylands, drawing attention to technical (external) solutions. However, in certain drylands, internal responses have evolved, both to constraints and to opportunities,. These draw attention to local knowledge, technical adaptation and capacity to invest, as well as to the critical role of appropriate and well-timed interventions. They indicate an impressive degree of success on the part of small producers. Lessons can be learnt from these stories, whether they are replicable elsewhere, and under what conditions.[10] The seven stories come from African drylands, where rapid demographic and economic change (and rainfall decline in the Sahel) offer major challenges.

***Machakos and Makueni Districts, Kenya*[11]**
The changes observed in Machakos District over a period of 60 years led to findings linking up population growth, market development and sustainable environmental management.[12] In the 1930s

[10] Reij,C. and Steeds,D. (2003) *Success stories in Africa's drylands: supporting advocates and answering skeptics.* A paper commissioned by the Global Mechanism of the Convention to Combat Desertification. Amsterdam: Centre for International Cooperation, Vrije Universiteit Amsterdam.

[11] This area is hilly with rainfall varying from <500 mm to >1,000 mm/yr; deeply weathered but eroded soils rapidly losing fertility under cultivation; and population densities from <50 to >200/km^2.

and 1940s, officials were extremely concerned about erosion on the hillside farms and the clearance of dry woodland. Yet the District saw the value of output per hectare increase sevenfold between the 1930s and the 1980s **(Box 3)**. On a per capita basis, a doubling occurred, even though the population had risen fivefold.

The Akamba farmers achieved this by means of a fundamental transformation of their farming system. The following changes took place: a dramatic reversal of erosion, thanks to the construction of thousands of km of farm terraces and field drains; improved productivity, through integrated crop-livestock production systems; new or adapted farm technologies; increased labour inputs; and increased private investments, which were financed in part from off-farm incomes.

The factors responsible for these change were as follows:

- Customary land tenure provided enough security to encourage farmers' investments; later this was reinforced by registration of title.
- Trading, travelling and education gave access to incomes outside the District, some of them used for farm investments.
- New knowledge and technologies became available from neighbouring European farms and missions, government extension, private sector service providers, on-farm experimentation and community exchanges.
- Project interventions played a key role at certain times, and in particular during the 1940s (African Land Development Board, whose coercive conservation measures were initially successful but later widely neglected), and the 1970s (the Machakos Integrated Development Programme, which assisted the revival of conservation that made Machakos what it is today). However, even at its peak, the greater part of investment was private.
- Integrating crop with livestock production provided on-farm synergies, additional revenue per ha, and better nutrient management.
- Access to urban and overseas markets, via the Nairobi-Mombasa highway and rail line, offered the necessary incentives for commercial production of coffee, fruit and horticultural produce.
- Institutional flexibility assisted in disseminating knowledge, mobilising labour (notably in womens' work groups) and in other ways.

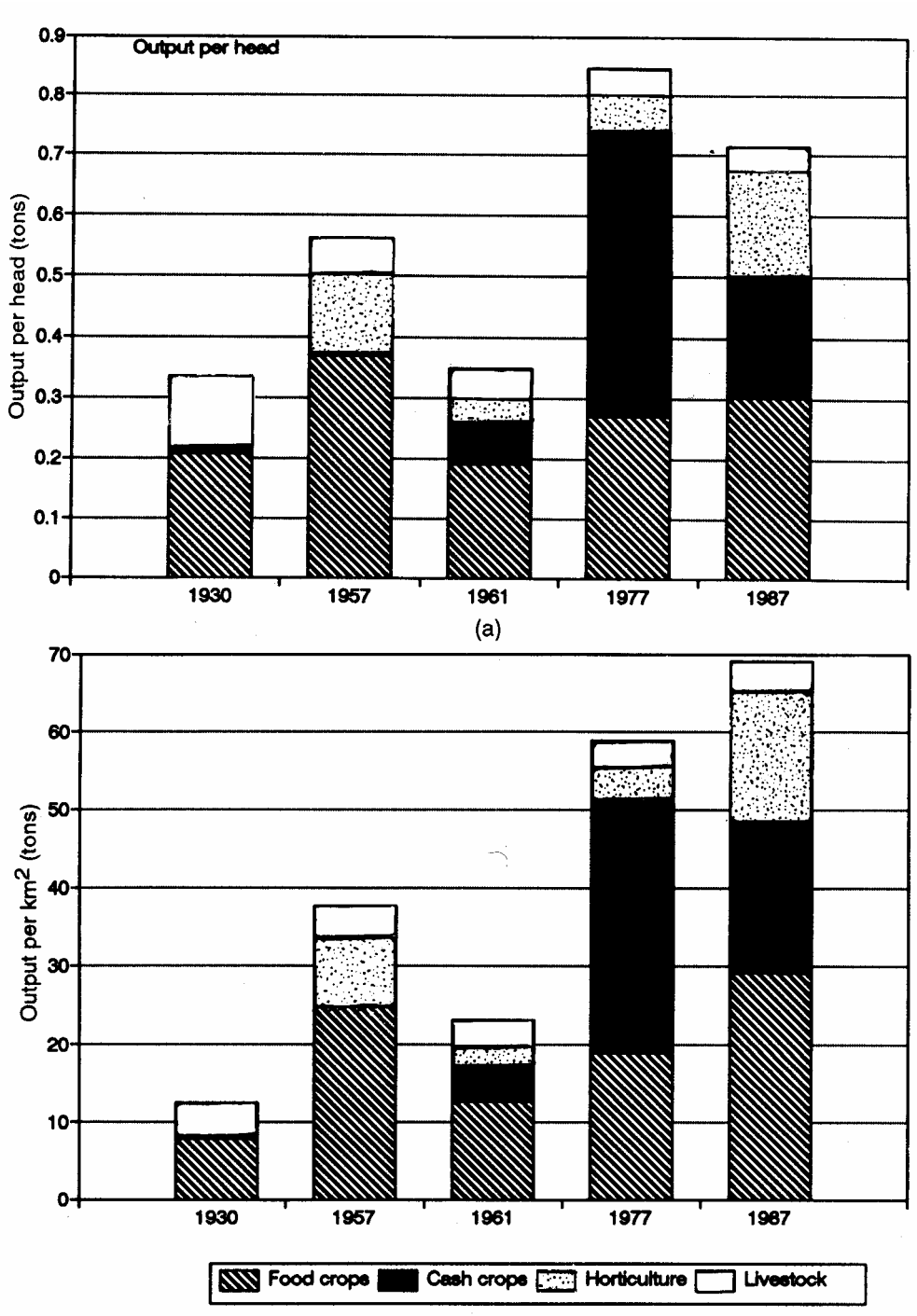
The relaxation of restrictive practices by the government (e.g., allowing Africans to grow coffee, 1954; allowing inter-district trade in food commodities, 1980s) gave more freedom to farmers and entrepreneurs.

Box 3: Value of output per capita and per km^2 in Machakos District, Kenya, 1930-1987

These charts, which are based on the inadequate data available, show in value terms what farmers achieved over the long term. The values are expressed as equivalents of maize (which is the staple cereal food), using 1957 prices for the years 1930, 1957 and 1961, and 1977 and 1987 prices for the later years. The fall in values in 1961 was because there was a widespread drought in that year, which affected both of the short growing seasons (March-May and October-December). The fall in per capita value of output in 1987 was due to falling prices for coffee and cotton (the principal components of 'cash crops'). Actual production increased, as may be inferred from the continuing rise in value per square km^2. After 1987, trends have not been analysed.

Source: Tiffen,M., Mortimore,M. and Gichuki,F. (1994) *More people, less erosion. Environmental recovery in Kenya:* 95. Chichester: John Wiley

[12] Tiffen, M., Mortimore, M. and Gichuki, F. (1994) *More people, less erosion. Environmental recovery in Kenya.* Chichester: John Wiley.



In 1999, follow-up studies in the new Makueni District (which includes the driest part of the old Machakos District) showed that the achievements in natural resource management had not been put at risk by a decade of structural adjustment and falling prices, even in this drier area. However, off-farm incomes had become harder to find, and poor families were struggling to continue investing in education. There was still poverty in such households if they had not succeeded in diversifying.

Northern and Eastern Burkina Faso

The Central Plateau[13] was suffering from degrading soils, declining yields, a loss of natural vegetation, falling water tables and out-migration of up to 25% of families (though village populations still increased) in 1980. The common view was that droughts, food shortages and degradation were endemic and continued into the 1990s.

However, a study of the northern and densely populated Plateau presented a contrary picture.[14] Over a relatively short period of 20 years, significant increases occurred in crop yields **(Box 4)**.

Box 4: Improving grain yields in three provinces, Burkina Faso (kg/ha)

Sorghum and millet are the main cereal staple foods. Yields per ha, averaged over five years at three points during the past 20 years, show a consistent improvement. It should be noted that the five-year averages include drought years.

Province and crop	*1984-88*	*1989-95*	*1995-2001*
1 Bam			
Sorghum	446	489	703
Millet	406	478	619
2 Yatenga			
Sorghum	594	534	733
Millet	473	539	688
3 Sanmatenga			
Sorghum	408	644	680
Millet	509	515	580

Source: Reij,C. and Thiombiano, E. (2003) *Développement rural et environnement au Burkina Faso: la réhabilitation de la capacité productive des terroirs sur la partie nord du Plateau Central entre 1980 et 2001:* 16. Amsterdam: Centre for International Cooperation, Vrije Universiteit Amsterdam

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Additionally, the following improvements in natural resource management were observed, in particular, in villages practising soil and water conservation:

- soil and water conservation work led to an increase in on-farm trees (assisting soil protection),
- livestock owned by farmers increased in numbers (providing manure),
- there was a better regeneration of vegetation (providing fodder),
- livestock management was evolving from extensive to semi-intensive,
- local groundwater levels rose substantially,
- out-migration decreased, with some return migration, and
- household food security and rural poverty improved.

These changes ran concurrently with the widespread adoption of soil and water technologies by the Mossi farmers, but not all of the achievements can be credited to that. A critical role was played by sound macro-economic management, and improvements to the infrastructure, thereby linking producers better with markets. Much has been achieved, but much remains to be done (e.g., on improving soil fertility and controlling degradation on uncultivated land).

Over a longer period of 40 years, changes in the Eastern Region.[15] have been documented in another study.[16] Several trends that are often considered to be linked to degradation were experienced: a

[13] This area has 500-700 mm of annual rainfall, soils of marginal fertility, and population densities up to 100/km^2.

[14] Reij,C. and Thiombiano, E. (2003) *Développement rural et environnement au Burkina Faso: la réhabilitation de la capacité productive des terroirs sur la partie nord du Plateau Central entre 1980 et 2001.* Amsterdam: CIS, Vrije Universiteit Amsterdam.

[15] This area has 600-900 mm of annual rainfall, soils of limited depth and low fertility, and population densities ranging up to 60/km^2.

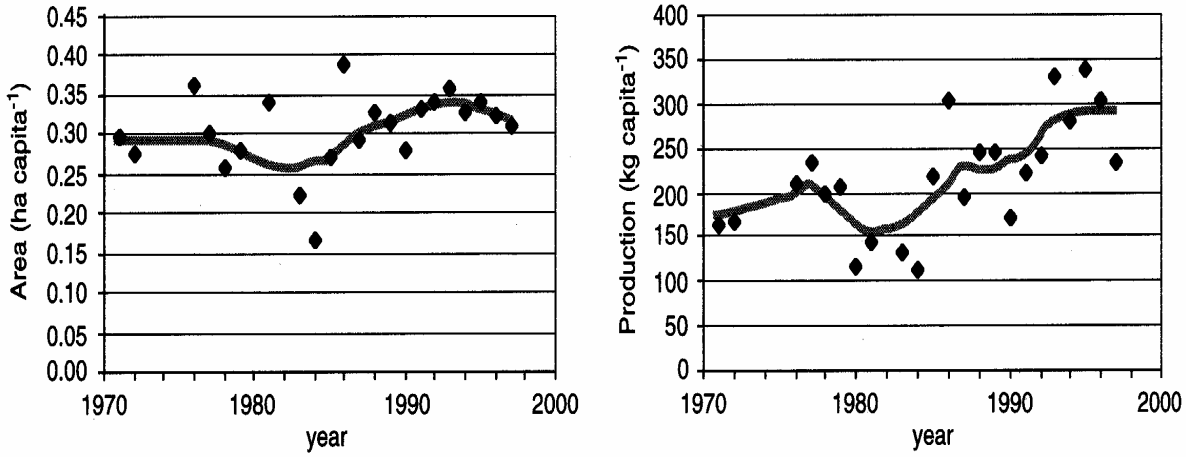
[16] Mazzucato, V. and Niemeijer, D. (2000) *Rethinking soil and water conservation in a changing society: a case study on eastern Burkina Faso. Tropical Resource management papers 32.* Wageningen: Wageningen University and Research Centre.

quadrupling of the human populations, a tripling of livestock numbers, and a decline in average annual rainfall since the 1950s of about 300 mm. But instead of evidences of stress, the study found that average production of staple grains per capita increased more rapidly than the area cultivated after 1980 **(Box 5)**; and that average yields increased by some 400 kg ha^{-1}, without evidence of soil degradation.

There is a large repertoire of soil and water conservation strategies that also increase productivity. Farmers adjust, adapt, and experiment. Mechanisation and inorganic fertilizers only explain a small part of the yield increases. The Gourmantché farmers maintained a productive and environmentally sustainable production system in spite of changing natural and social conditions, successfully adapting their institutions which regulate access to natural resources.

Box 5: Improving grain production in Burkina Faso's Eastern Province, 1970-2000

In the early 1980s, as in most other West African countries, there was a failure in agriculture reflected in falling cereal areas and output. After this low, both the area planted to millet and sorghum, and the amount produced, increased on a per capita basis. The first indicator, however, faltered as land became scarce in the 1990s, while the second continued to increase. This provides evidence of intensification.



a. millet and sorghum area per capita

b. millet and sorghum production per capita

Source: Mazzucato, V. and Niemeijer, D. (2000) *Rethinking soil and water conservation in a changing society: a case study on eastern Burkina Faso. Tropical Resource management papers 32.* Wageningen: Wageningen University and Research Centre.

Nigeria: the Kano Close-Settled Zone (KCSZ).[17]
Two critical factors in 'success stories' are population growth and markets. Their interactions are illustrated by the next two stories from northern Nigeria.

In the KCSZ, rural population densities increased from 226 per km^{-2} in 1962 to 414 per km^{-2} in 1991. The practice of divisible inheritance ensured that smallholdings became smaller on average with each generation, and the amount of farmland available now averages <0.5 ha per member of resident farming families. But instead of inducing degradation of the natural resources, this demographic pressure was accompanied by a continuation of a long-term trajectory of agricultural intensification that had been in place for at least 150 years (**Box 6**).

Externally funded, State-wide, agricultural development support was introduced in 1981. Subsidised inorganic fertilizers, technologies, advice, road infrastructure and other kinds of support were available, though thinly spread among a population approaching 10 million. Scaling down of activities and

[17] This area has 650-700 mm of annual rainfall (a decline of nearly 200 mm between the 1960s and the 1990s), sandy soils whose fertility is low, and on-farm population densities rising to >220/km^2. Average slopes are low.

removal of subsidies took effect in the 1990s, but significant technical changes have been adopted widely since 1981 (e.g., new varieties of groundnut, cowpea and maize, many more ox-drawn ploughs and ridgers). Most of these changes, if not all, are privately financed. Growing labour, input and land markets are making Hausa and Fulani farmers more reliant on capital resources. Successful livelihoods depend on accessing off-farm incomes with which to finance farm investments and reduce dependency on home-produced food. Those without such opportunities are food-insecure.

Box 6: Agricultural intensification by smallholders in the Kano Close-Settled Zone.

The methods and achievements of small farmers in the KCSZ are relevant to the search for intensification strategies in dryland environments. Farmland is under annual cultivation, with no fallowing, except on <10% of fields, where labour or inputs are not available. Over 85% of the surface is under this regime (excluding settlements, communications, burial grounds, waste, etc.)

By efficiently recycling plant nutrients through intensive grazing, manuring and composting, and by allocating large amounts of family labour to fertilizing and weed suppression, farmers can secure grain yields of >1,000 kg per ha^{-1} and 350 kg per capita under average rainfall (650 mm). Without fertilizing, yields fall to a half or a quarter and farming becomes non-viable. Livestock are kept by nearly all households, and are valued highly. The more people there are, the more livestock. As there is no rangeland, they depend on crop residues and weeds or tree browse laboriously cut for them. Annual manure/dry compost treatments are in the order of 3.5-5.0 t ha^{-1}. This material is a composite of animal manure, household refuse, vegetable matter and ash. Estimations made in 1968 suggest 40 Tropical Livestock Units per km^{-2} which may produce 43 t km^{-2} or 0.43 t ha^{-1} of manure. Mixed with the other materials this may yield 4 t ha^{-1}. Inorganic fertilizers are used, but on a very small scale (owing to their cost). Nitrogen added per ha is usually less than that obtained through fixation by leguminous crops, or that supplied in manures. Key soil nutrients at the field level fluctuate with rainfall, cropping system and the farmer's ability to provide inputs. However, comparative analyses at the same sites over a 13-year period suggested no significant trend at that time-scale.

Sources: Harris,F.M.A.(1998) 'Farm-level assessment of the nutrient balance in northern Nigeria', *Agriculture, Ecosystems & Environment,* 71:201-214; Harris,F. and Yusuf, M.A. (2001) 'Manure management by smallholder farmers in the Kano Close-Settled Zone, Nigeria', *Experimental Agriculture,* 37:319-332

Grain markets in northern Nigeria

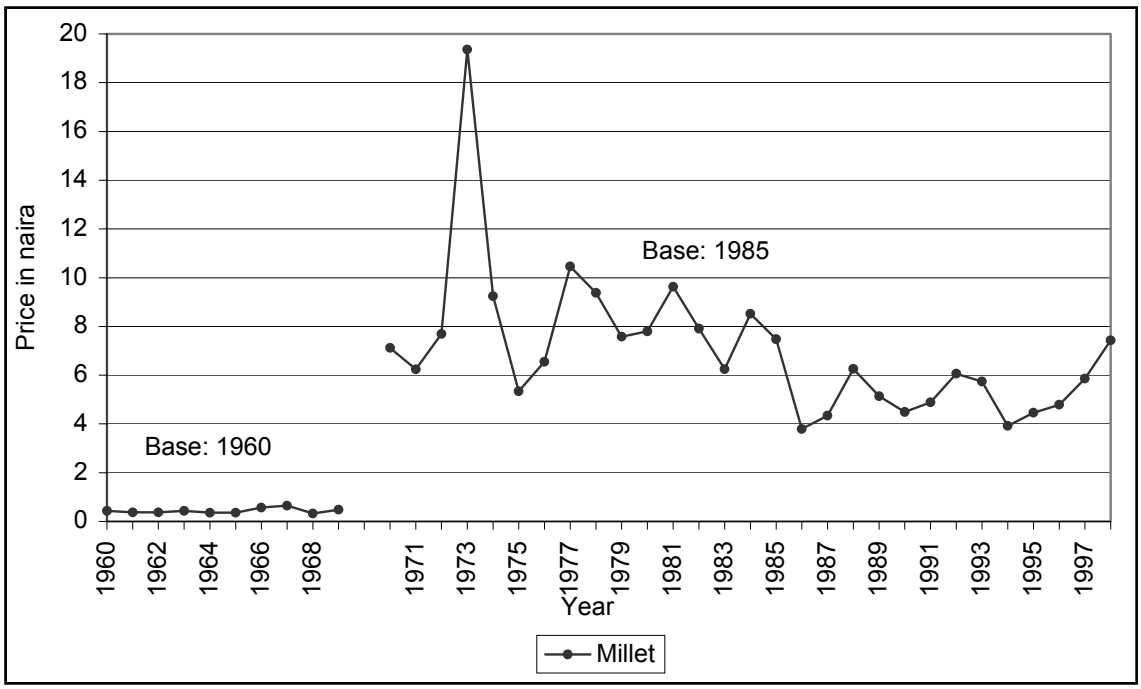
Throughout the twentieth century, Hausa farmers in Kano's dry hinterland, working in the proximity of one of the greatest markets in West Africa, adjusted to changing economic circumstances and a background of agrarian policy shifts.[18] They formerly supplied the city with its staple grains, but after the railway came in 1911, they diversified into growing groundnuts for export. After decades of prosperity, this trade collapsed with drought and rosette disease in 1975. However, urban consumers in Kano increased from 0.25 million in the 1960s to >1.5 million in 1991. Kano, not surprisingly, is a focal point for food marketing in a wide region. The KCSZ can no longer supply all its needs, but its markets provide incentives for farmers. In spite of increasing demand, land scarcity and diminishing rainfall, real prices of millet trended downwards during the 1980s and 1990s, implying increased productivity **(Box 7)**.

Box 7: Downward trend in real prices of millet (per ton) in Kano urban markets, 1960-98

Consumers complained of rapid price inflation from the Sahel Drought (1972-74) onwards, but this reflected nominal prices during general inflation. Producers complained of rising marketing costs. Real prices in fact trended downwards, suggesting that supply constraints (land scarcity, low soil fertility,

[18] Mustapha,A.R. and Meagher,K. (2000) 'Agrarian production, public policy and the state in Kano region, 1900-2000'. *Drylands Research Working Paper 35.* Crewkerne: Drylands Research

high cost of fertilizers, middlemens' margins and illegal rent-seeking in the market chain, fuel scarcities, etc.) were overcome successfully. The prices reflect not only local demand but national trade in food commodities and cross-border movements to or from Niger.



Source: Ariyo,J., Voh,J. and Ahmed,B. (2001) 'Long term change in food marketing in the Kano region, 1960-2000' *Drylands Research Working Paper 34.* Crewkerne: Drylands Research

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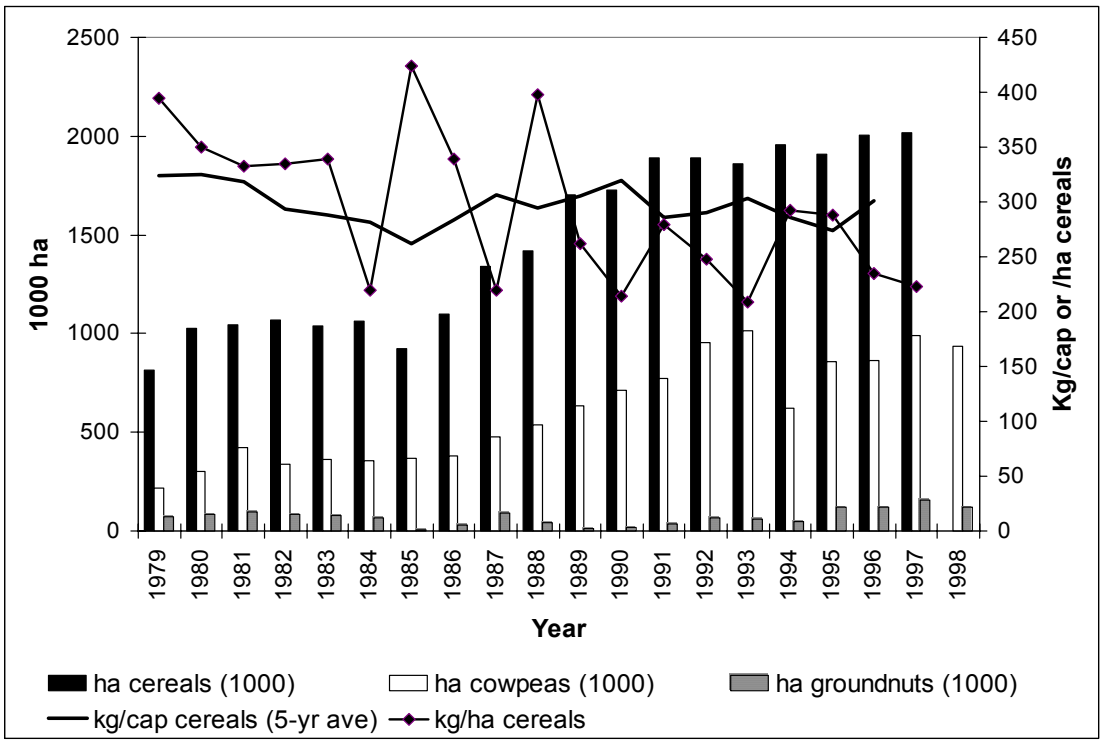
Box 8: Planted areas and crop production in Maradi, 1979-98



Areas planted to cereals doubled between the early 1980s and the late 1990s. The state (transferring its dependence from groundnut exports to newly-discovered uranium) had adopted a 'self-sufficiency' policy after the Sahel Drought, with inputs, marketing, and development programmes. There was also a response to land tenure reform, which motivated farmers to claim private rights by cultivating unclaimed land. But this expansion levelled off after 1994, whereas yields per ha maintained an upward trend during the 1990s, though still very low. Cereal (millet and sorghum) production, though falling after droughts, showed no long-term decline. Millet output tended upward under 'self-sufficiency' (1975-1985) and structural adjustment (1986-1998), when the end of the uranium boom brought unsustainable debts. From 1979 to 1998, output was sustained above 200kg/cap, which approximates average food requirements.

Source: Hamadou, S. (2000) 'Evolutions à long terme des productions agricoles, du système de commercialisation et des prix des produits dans la zone de Maradi'. *Drylands Research Working Paper 32.* Crewkerne: Drylands Research

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Incipient success - Niger: Maradi Department[19]

On the northern fringe of Hausaland, but within reach of the markets at Kano, Maradi Department south of the pastoral zone was stressed by rapid population growth, as a result of a sustained influx of land-hungry farmers into drier areas.[20] After the drought cycle of the 1970s, production of groundnuts, whose export had been the mainstay of the government's economic policy, collapsed, and grain deficits became common. The rising population densities, the growing scarcity of new land, with reports of degradation of soil and vegetation, shortening of fallow cycles and declining crop yields, and overgrazing by armies of cattle and small ruminants, suggested that the productive and social systems were not sustainable. By the early 1990s, land 'saturation' (no more unclaimed farmland) was general.

In Maradi Department, however, food production was sustained. Average output per capita exceeded the minimal estimated food requirement, even after 'saturation', and in the south, where the conditions for a transition (land scarcity, more agricultural labour, and market incentives from trade with Nigeria) are present, there was evidence of intensification (**Box 8**).

Other indicators of a transition are: a decline of fallowing; more grazing of livestock on fields; increased attention to fertility maintenance (mulching, composting, manuring and mineral fertilizers); new seeding, cultivation and tree conservation measures; a growing popularity of protecting valuable trees on farmland; adaptations of the customary land tenure system to take care of land scarcity and increasing individualisation; investments in livestock, ploughs, planters and carts; and increasing roles for women in farm investments. Groundnut yielded place to cowpea as the primary market crop. The data show no evidence of a decline in the livestock population, except after droughts. Like cowpeas, animal production is targeted on the buoyant markets in Nigeria.

Struggling to adapt - Senegal: Diourbel Region[21]

Diourbel is at the centre of the groundnut-exporting region or 'peanut basin'. Its population of Wolof and Sereer mixed farmers grow millet for subsistence. The collapse of centrally directed agricultural policy in Senegal is briefly described in Section 2.[22]

After 1969 the Region was hit hard by droughts, which reduced average annual rainfall from over 600 mm to about 400 mm. In the 1980s, observers thought that the export of plant nutrients in the groundnuts, declining yields, inadequate fertilization, and shortening fallows, threatened a collapse of the production systems, but the ending of the *Programme National Agricole* was decisive. Producers had few alternatives to groundnuts, as Senegalese consumers had acquired a preference for rice, which was imported and sold under subsidy. On the other hand, state control of farm profits made families

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[19] This area has mean annual rainfall increasing from 250 mm in the north to 450 mm in the south, coarse sandy desert-edge soils, and rural population densities rising from about 13/ km^2 in 1960 to about 44/km^2 in 1999.

[20] Mortimore,M., Tiffen,M., Boubacar,Y. and Nelson,J. (2001) 'Synthesis of long-term change in Maradi Department, Niger, 1960-2000'. *Drylands Research Working Paper 39e.* Crewkerne: Drylands Research.

[21] This area has a mean annual rainfall of 450 mm, has sandy unproductive soils on gentle slopes, and variable population densities, 46-151/km^2. Over 80% of the land has been under cultivation or short, one-year fallows since 1954.

[22] Faye,A., Fall,A., Tiffen,M., Mortimore,M., and Nelson,J. (2001) 'Région de Diourbel: Synthesis'. *Drylands Research Working Paper 23e.*Crewkerne: Drylands Research.

more reliant on off-farm earnings, and the social networks that gave access to these. Much rural wealth was invested in Dakar.

A closer look at the rural sector reveals, however, that important adjustments have been made by farmers (**Box 9**). In crop production, there is suggestive evidence that yields of millet and groundnuts per mm of rainfall (which is the most scarce factor) have improved, owing to technical changes. Millet yields per ha and per agricultural worker also improved. Livestock numbers were maintained (cattle) or increased substantially (small ruminants). Fattening animals became both profitable and popular, based on the intensive use and exchange of crop residues. Animals are popular investments, including for women, and as added value to farming systems.

Diourbel shows that demand incentives can drive vigorous adaptive strategies, even where dependence on the state had become a habit. This is taking place in the face of severe constraints in soil productivity and rainfall.

Box 9: Adjustments to policy failure in Diourbel, Senegal

Over the long term (1960-2000), the staple food commodity, millet, was undermined by competition from rice, and production per capita fell by 50% nationally. However, trends in use-efficiency of scarce factors were positive. Millet yields per hectare rose by about 20% over the period, yields per mm of rainfall doubled, and yields per agricultural worker rose by about 25% after a low point in 1980/81. A similar contradiction appears in groundnuts: output/capita went into rapid decline, and yield/ha a rather slower decline, but there was a noticeably rising trend in yield/ mm of rainfall, resulting from increasing adoption of drought-resistant, upright varieties.

In the livestock sector, numbers of cattle, donkeys and horses fluctuated around mean values that did not change significantly over the 30 years, while small ruminants roughly doubled in number. Between 1975 and 1981, the numbers of cattle managed for fattening in Diourbel increased from 350 to 10,437, and those of small ruminants from 1,409 to 31,430. The trends reflect increasing capacities among poor people, including women, to buy or rear goats or sheep for economic gain, as well as buoyant meat prices after devaluation raised the price of imported meat in 1994. More livestock facilitate the integration of crop with livestock production, with synergies in draft energy and in soil fertility, on manured fields. But organic materials cannot fully compensate for the inorganic fertilizers which farmers can no longer afford.

Source: Faye,A., Fall,A., and Coulibaly,D. (2001) 'Région de Diourbel: évolution de la production agricole' *Drylands Research Working Paper 16.* Crewkerne: Drylands Research

Rewards of 'success'

There is evidence in the 'success stories' that:

- increased populations have continued to support themselves (though not exclusively) from agrarian livelihoods, at densities higher than any experienced in the past;
- markets have been extremely important in driving change, and farmers have been responsive to market opportunities;
- farming systems have tended to move towards more intensive, diverse and environmentally sustainable combinations of crops, livestock and technologies;
- households and individuals have found it necessary and advantageous to diversify their incomes out of agriculture, including increasing their participation in short-term migration;
- macro-economic policies have had discernible effects, both positive and negative, on the pursuit of livelihood objectives;
- customary land tenure has adapted, where necessary, to land scarcity and also to legislative or project interventions by the state;
- social institutions have not impeded individual or community action, and the household remains the locus of diverse economic activity, investments, and the sharing of risks or benefits.

The 'incipient success stories', while still inconclusive, suggest that these positive changes are capable of wider replication. Policy determinants will be referred to again below.

4. Food Security Under Threat? Evidence of Resilience

An often-repeated consensus view is that agriculture in Sub-Saharan Africa, in contrast to Asia, has failed to perform as expected during the past 40 years. For example, a policy paper of one donor states that agricultural production declined by five percent between 1980 and 2001, whilst the absolute number of people going hungry increased by 50 percent.[23] Among the reasons given for this state of affairs are falling commodity prices, poor incentives, ineffective aid and a decline in private investment.

Is this view accurate, and applicable to all countries? The success stories suggest otherwise.

An aggregated statistic disguises the differences both between countries, and between export and food crop production. Certainly export agriculture has declined severely in West Africa, as long-term data show.[24] Only cocoa exports from Côte d'Ivoire maintained a strong upward trend over the four decades, 1961-2000. In Mali, cotton exports rose steeply until 1976, fell equally steeply until 1985, and then stabilised. Cocoa stagnated or declined in Ghana and Nigeria. Exports of cotton, groundnuts, and (in coastal countries) palm oil and kernels declined or collapsed in several countries.

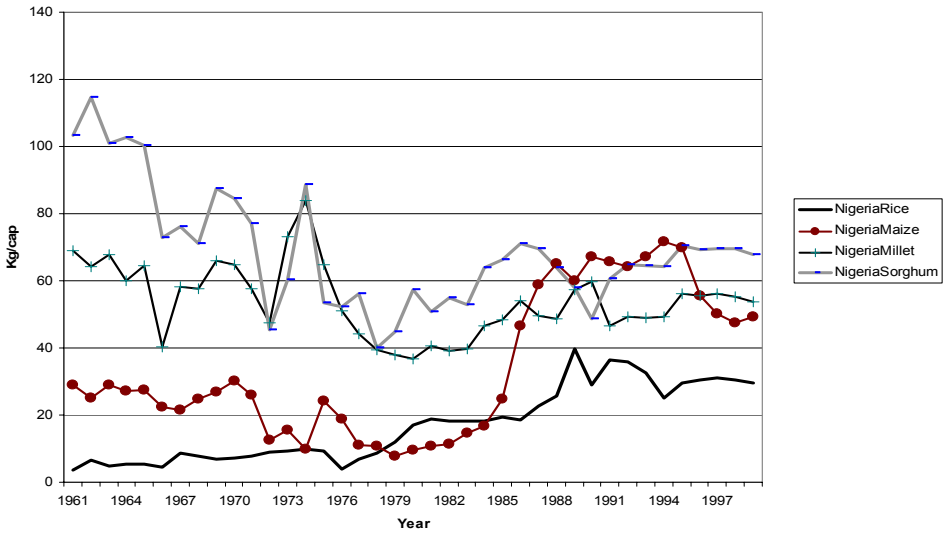
On the other hand, food production per capita, notwithstanding the growth of population, increased by 4% between 1969/71 and 1997/99. However, the long-term data published by the FAO show that country performances in the food-producing sector did not conform to a general pattern (**Box 10**). They reflect the various impacts of declining producer prices for the export crops, increasing domestic demand, government policies, and droughts. Also, the substitution of imported foods (rice or wheat) for domestically produced cereals (millet, sorghum, maize), and of roots or tubers (yams, cassava) for the dryland cereals, continually reshape the food commodity markets. Buoyant markets have grown up for the protein-rich cowpea, which is mainly grown in semi-arid areas. The livestock sector is also buoyant, benefiting from rising incomes among better-off urban consumers.

Thus dryland cereal production has tended to keep up with demand over the long term, except where explicitly discouraged by policy. The resilience of the food producing sub-sector is more remarkable than its weakness in the face of supply constraints.

Box 10: Long-term performance of the cereal producing sub-sector in West Africa

What narratives do the long-term data suggest with regard to the food commodity subsector, and in particular, cereal grains produced in the drylands? Findings from a study of six countries emphasise the critical role played by policy, as the following examples show.

Box Figure 10A Cereal crop production, Nigeria (per caput)



[23] DFID (2003) *Agriculture and poverty reduction: unlocking the potential. A DFID policy paper:* 1, 3. London: Department for International Development.
[24] Mortimore,M. (2003) *op.cit.*

Figure A (Nigeria)

In Nigeria, the agricultural sector saw major policy-related changes, in particular *Operation Feed the Nation* (fertilizer subsidies, import protection, technology promotion (maize), and irrigation (rice)) in the 1970s, and its own version of structural adjustment (which retained the first two), from1986. The decline or stagnation which affected dryland cereal crops from the 1960s were successfully reversed. The 'new' dryland cereals increased dramatically, but fell back (maize) or stagnated (rice) in the 1990s. The 'old' dryland cereals (millet and sorghum) also recovered from decline in the 1980s. In the 40 years, cereal production per capita of the national population did not change significantly (-1.2% overall), and in aggregate, dryland cereal production was maintained at about 200 kg/caput of the total population, notwithstanding the fact that half of Nigerians rely on roots and tubers more than on cereals.

Box Figure 10B Cereal production, Mali (per caput)

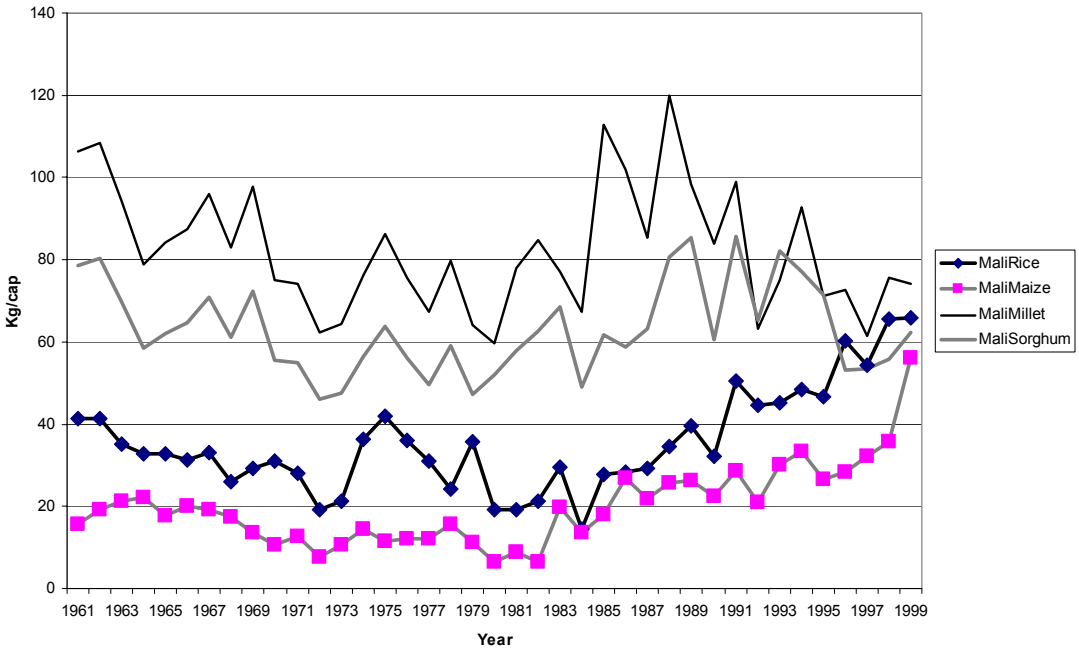


Figure B (Mali)

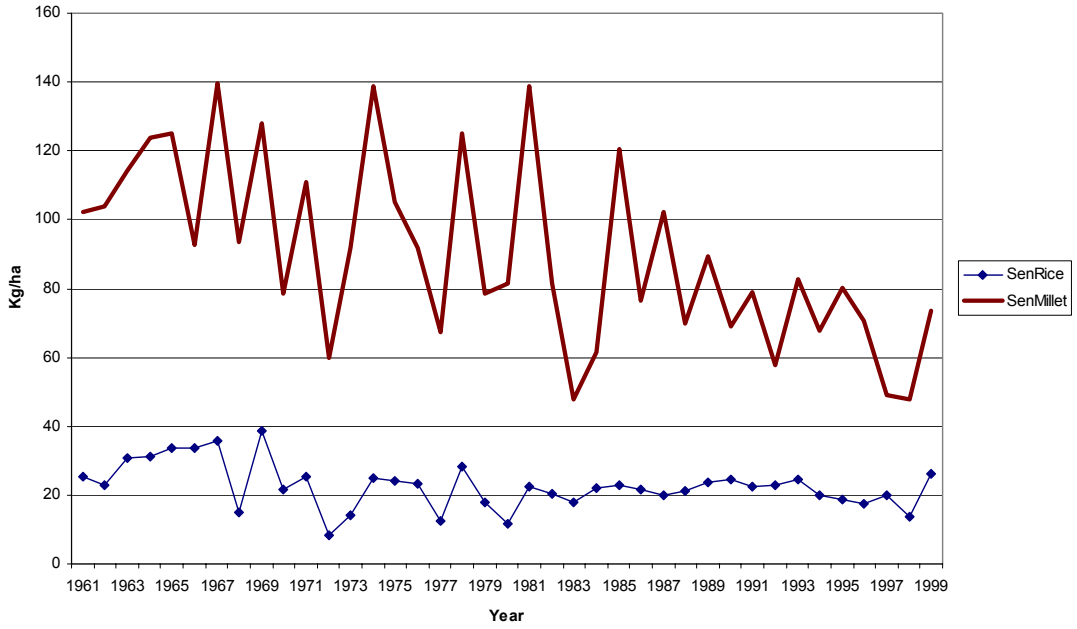
Data are available for the same four crops in Mali, a country which lacked a large humid zone, enjoyed no oil boom, and is little urbanised - three factors which had impact on the Nigerian story. Yet the pattern was similar: decline in output per capita (though less marked than in Nigeria) until around 1980, followed by improvement under structural adjustment, which was lasting in the 'new' but short-lived in the 'old' cereals. The difference was that demand for the 'new' cereals was growing, and by the end of the 1990s, they had achieved equality (more or less) with the 'old' cereals. Production of all cereals per capita again showed no significant change over the 40 years (-2.6% overall), remaining well above 200 kg/cap.

Figure C (Senegal)

Even stronger evidence of the influence of policy – this time, negative - is shown in data for Senegal. There, sorghum and maize are comparatively unimportant. Thanks to a policy of dependency on imported rice, millet (the traditional staple) declined notably over the period as a whole. Rice, now the

preferred staple, was unable to compensate. Irrigated production in the Senegal River valley was beset with management problems. Overall, cereal production fell by 41% per caput.

Box Figure 10C Cereal crop production, Senegal (per caput)



Source: Mortimore, M. (2003) 'The future of family farms in West Africa. What can we learn from long-term data?' *Issue Paper No 119.* London: Drylands Programme, International Institute for Environment and Development.

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5. Drylands Degrading? Reversing the Trends

A widely held view of drylands is that the ability of the ecosystems to provide goods and services has been compromised by degradation of land, water and biodiversity. Public sector and donor investments therefore have a high probability of yielding low or zero returns, and need to be justified more on social than on economic grounds. This view is informed by a narrative of degradation that has been dominant since UNCOD in 1977.

The 'greening of the Sahel'.

Environmental change in the Sahel has sustained much scientific interest for four decades. Several devastating drought cycles affected the region between the late 1960s and the 1990s. Average annual rainfall declined by up to 30% between 1931-60 and 1961-90, and did not fully recover by 2001. Land degradation has also been blamed on mismanagement by farmers and pastoralists.

However, time-series data from earth satellites have recently been analysed for the region.[25] A vegetation 'greenness' index (Normalised Difference Vegetation Index, NDVI) derived from AVHRR data shows a strong increase in values between 1982 and 1999. This improvement took place mainly in the period after 1993. Preliminary studies indicate a continuation of the trend through 2003. Quality assessments of other parameters linked with the data support the conclusion that the observed trend is a real change on the land surface.

Analyses of the rainfall data show an increase during the same period. The greening, however, is not uniform, and in some places, negative trends are observed. This suggests that factors other than rainfall

[25] UNEP (2003) *Workshop on Changes in the Sahel, Nairobi, 14-16 October, 2003. Preliminary Report, Abstracts.* Nairobi: United Nations Environment Programme.

are also contributing. These factors need to be studied through site-specific investigations on the ground, as the resolution of the satellite data is coarse (8 km).

It is too early to say whether the greening represents a 'recovery' from the trend of declining rainfall and land degradation. As the data series begins at the base of a drought cycle - that of the early 1980s - some improvement would be expected in subsequent years. Comparable NDVI data are not available for the period before 1970. Earlier studies using satellite data had already shown vegetation changes with rainfall fluctuations on the southern edge of the Sahara. The geological record shows evidence of longer term swings between desert and savannah conditions.

It would be mistaken to expect the vegetation in the Sahel to return to an earlier equilibrium, as the rainfall still falls far short of the levels experienced before the 1970s, and some of the changes that have occurred may be irreversible. The ecology of the Sahel is not equilibrial in nature. Communities whose livelihoods are based on the natural resources must continue adapting to such uncertainty. Much more understanding of the human-environmental interactions is required.

However the greening of the Sahel shows that a simple projection of recent trends into the future is not a sound basis for policy, which until now has been informed by a narrative of degradation. As the 'success stories' show, farmers have found ways to improve their management of natural resources. Policy needs to release the creativity of farmers and livestock producers, so that they may be better able to deal with the return of drought. Greening - whatever exactly it indicates on the ground - does not justify rolling back degradation control. Rather, it shows that positive trends are achievable.

Tree management in the Sahel

One landscape transformation, which illustrates the need for a critical evaluation of the degradation narrative, is in the management of trees and woodland. Sahelian farmers and pastoralists were accused from colonial times of irresponsible destruction, by fire, farming and woodcutting, and repressive legislation was imposed to 'protect' the trees. Wood fuel consumption by growing populations was held to account. Shifting cultivation was also blamed for destructive burning. More significantly still, during the past half-century there has been a dramatic increase in the clearance of land for farming, with a corresponding reduction in natural woodland. In more densely-populated areas, the cultivated fraction increased from <25% to >70%. Such data tend to encourage the global scenario of 'deforestation'.

Much new evidence shows that there is another side to Sahelian 'deforestation'. An emerging consensus suggests that the 'wood fuel crisis' has been exaggerated, owing to under-estimation of woodland areas and yields.[26] Woodland management is more sustainable than was previously supposed, and even urban demands pose no long-term threat. Field studies show that land clearance for shifting cultivation is rotational, and mature trees are normally pollarded (not felled) to facilitate their regeneration after the cultivation cycle. When shifting cultivation gives way to permanent fields, these valuable trees grow to full canopy, and seedlings, regenerating spontaneously, are given protection until grown to maturity. They may also be planted. The emerging 'farmed parkland' vegetation may support more plant biomass than neighbouring woodland. The following cases are illustrative:

- In the *Kano Close-Settled Zone* of northern Nigeria, old established farmed parkland has mature tree densities of 7-15/ha. Although some species are becoming rare, the population as a whole is regenerating. While harvesting wood fuel, and selling to urban dealers, farmers managed to maintain stable or increasing tree densities from the 1960s to the 1980s, despite two drought cycles when they were under pressure to raise incomes from selling wood.[27]
- In *Maradi Department* of Niger, where rapid conversion of forest to farmland took place from the 1920s until the 1970s, farmed parkland can now be seen on permanent fields close to villages, and the practice of protecting valuable seedlings is popular, and is promoted by policy.

[26] Foley,G. (2001). Sustainable woodfuel supplies from the dry tropical woodlands. ESMAP Technical Paper 013. Washington, D.C.: The World Bank.

[27] Cline-Cole,R.A., Falola,J.A., Main,H.A.C., Mortimore,M., Nichol,J.E., and O'Reilly,F.D. (1990). Wood Fuel in Kano. Tokyo: United Nations University Press.

- In the *'Peanut Basin'* of Senegal, falling tree densities have been reported on farmland. However, field surveys at four sites (where farmed parkland is >75% of the surface) show tree densities of 14-30/ha including seedlings.

Farmed parkland is now so extensive in West Africa that increasing densities of mature trees can be expected have a long-term signature on remotely sensed data. Furthermore, the multiple values of trees (including construction, crafts, food, fodder, medicines), together with the extensive indigenous knowledge held by communities, provide strong incentives for biodiversity conservation at local level. The same is true of herbage vegetation, which is more prone than trees to short-term rainfall effects. New approaches to biodiversity conservation should seek to support these capabilities, rather than over-ride them.

Soil management and carbon sequestration

Soil carbon is relatively scarce in drylands. The amount available to farmers increases with the rainfall, and therefore with the level of productivity they can achieve. Organic carbon in the soil depends to a large extent on recycling vegetation, either directly through biological action, or via livestock grazing and manuring. If plant nutrients are lost through soil degradation, or in crop removals, the capacity to produce plant biomass is reduced, but the more biomass, the greater the potential for replenishing soil carbon.

Carbon is also supplied by sequestration from the atmosphere by living plants. Increasing CO_2 sequestration is now a global preoccupation, along with reducing emissions, under the Kyoto Protocol. Until recently, the potential of drylands for sequestering atmospheric carbon was not highly regarded because the plant biomass stocks are relatively low, especially where degraded. However, this logic also means that proportionate gains could be made if degradation could be reversed. The vast territorial extent of the drylands has drawn attention to the possibility that a very small overall increment in plant biomass, achieved by improved management, could make a significant contribution to the global carbon budget. Such management options include:[28]

- Increased fallow periods
- Reduced tillage
- Incorporation of crop residues
- Mulching and green manuring
- Increased composting or manuring
- Rainwater harvesting
- Erosion control
- Agroforestry
- Irrigation
- Use of inorganic fertilizers and pest control
- Rehabilitation of degraded natural vegetation.

Many of these options are consistent with the aims of farmers and agro-pastoralists and have been taken up widely in the 'success stories'. Modelling studies suggest that within the structure of current dryland farming systems, including some of those referred to in this paper, alterations can be made which will lead to annual rates of carbon sequestration in the range 0.02-0.29 Mg ha^{-1} y^{-1}**.**[29] Whether a system of Carbon Emission Reduction credits (purchased by carbon emitters in industrial countries) could be an economic way of promoting improved practices, however, remains unproven.

The new political economy of carbon offers an opportunity to reverse the traditional view of drylands as a 'development sink'. Instead there is likely to be a stronger convergence of interests between the industrial-urban economies and the need for poverty reduction in the drylands. Incentives are critical at all levels, and it is to this subject that we now turn.

[28] USGS (2000) *Soil carbon sequestration in semi-arid and sub-humid Africa.* Sioux Falls: EROS Data Center, U.S.Geological Survey.

[29] Farage,P.K., Ardö,J., Olsson,L., Ball,A.S., Pretty,J.N. (in preparation). The potential for soil carbon sequestration in tropical dryland farmind systems of Africa, Asia and Latin America: a modelling approach.

6. Public Investments Failing? Evidence of Favourable Returns

Wrongly targeted, inappropriately designed or badly managed interventions have contributed to the view that drylands are a sink for public sector investments. But new evidence from India indicates, on the contrary, that economic rates of return may actually be higher in rainfed drylands than in humid and irrigated regions.[30] Rural districts were classified into predominantly irrigated or rainfed, and the rainfed areas were subdivided into 13 agro-ecological zones, which were ranked by land productivity. Historical data were used to estimate the returns to different types of investments (**Box 11**). Five categories of public investment were analysed: research on high yielding crop varieties, road infrastructure, canal irrigation, electricity, and education.

There is considerable variability among the rainfed zones, but many values for the semi-arid zones exceed those for irrigated or humid zones. On rural roads, electricity and education, the semi-arid zones performed better on average than irrigated areas. The authors also found that investments in rural roads and education had a greater impact on the numbers of poor people in rainfed zones.

Are such results replicable in Africa? The authors caution against transferring their findings from India to Africa because of historical divergences. In India, after several decades of agricultural investment and a green revolution, the best options for humid and irrigated areas may by now be exhausted. Hence the rainfed drylands offer some good returns (though as the data show, this is not inevitable).

Nevertheless, the question is very pertinent to African drylands. No comparable data have been compiled, but at project level, the authors of the study cited earlier present a number of histories which demonstrate good rates of return to investment or, if financial data are not available, reliable evidence of satisfactory uptake.[31]

Box 11: Marginal returns to investment by agroclimatic zone, rural India[a]

Zone		*Rainfall (mm/yr)*	*High yielding varieties*	*Rural roads*	*Canal irrigation*	*Electricity*	*Education*
Irrigated:		858	4.64	26.80	2.76	0.86	0.22
Rainfed: [b]							
Humid	1	1690	0.00	38.38	4.90	1.18	0.10
	2	1391	26.14	8.29	6.27	10.02	1.54
Subhumid	3	986	7.50	102.83	3.17	5.15	0.09
	4	902	0.00	29.94	3.63	0.80	2.50
	5	960	0.86	37.88	2.19	1.28	0.86
	6	918	12.87	135.85	3.51	1.09	1.07
	7	965	29.80	100.47	6.96	4.44	0.94
	8	924	0.41	137.28	7.81	4.28	2.41
Semi-arid	9	508	5.30	82.53	1.95	2.92	10.55
	10	649	9.21	9.14	0.14	6.90	6.76
	11	443	0.02	2.57	2.53	0.16	11.93
	12	719	10.67	50.88	2.71	5.78	1.10
	13	335	0.00	113.29	0.00	31.42	12.37

[a] Annual returns are in rupees for every rupee invested
[b] Rainfed zones are ranked by land productivity (I = highest, 13 = lowest)

Source: Shenggen Fan, Peter hazell and T.Haque, 'Targeting public investments by agro-ecological zone to achieve growth and poverty alleviation goals in rural India', *Food Policy* 25 (2000): 411-428.

[30] Hazell,P.,Jansen,H.,Ruben,R.and Kuyvenhoven,A. (2002) *Investing in poor people in poor lands. Paper prepared for IFAD.* Washington,D.C./ Wageningen: International Food Policy Research Institute/ Wageningen University and Research Centre.

[31] Reij,C. and Steeds,D. (2003) *Success stories in Africa's drylands: supporting advocates and answering skeptics.* Amsterdam: CIS/Centre for International Cooperation, Vrije Universiteit Amsterdam.

- *Soil and water conservation, Illela District, Niger.* This project promoted simple water harvesting techniques in a dry area with annual rainfall of 400mm. The project provided community infrastructure and tools-for-work, spending $1.5 million in 1988-95. Farmer visits to Burkina Faso, where improved planting pits had been taken up on a large scale, were decisive in popularising them in Illela, though they had not been a part of the project plan. About 9,000 ha were so treated, or 15% of the cropland. The project cost was $250/ha, and the on-farm incremental benefits were $65/ha/yr, giving an economic rate of return (ERR) at completion of 20%.
- *Farmer management of irrigation, Office du Niger, Mali.* Set up in 1932, this large government-controlled irrigation scheme was beset with poor maintenance, tenure insecurity, inefficient water management, land degradation and marketing problems. Rice yields were only 1.5 tons/ha in the 1980s. However, with the transfer of maintenance and water management to farmers' committees after 1986, yields increased to 5.5 tons/ha, crops were diversified, 30,000 ha were rehabilitated and 30,000 ha newly irrigated. Rice income increased from $450/ha in degraded land to $1,000/ha in rehabilitated land, and the ERR was 30%.
- *Forest resource management in Mwanza and Tabora Districts, Tanzania.* The aim of the project was to strengthen local forestry services as a part of the Forestry Action Plan. New field activities included community participation in forest management through local institutions, tree nurseries and improved wood stoves. A plan for joint government-community management in a 13,000 ha forest reserve was also included. The nurseries and wood stove projects yielded an internal ERR of 12%. Community management has been introduced, with benefits both for local empowerment and forest management.
- *Farmer-to-farmer extension, Tigray, Ethiopia.* Participatory approaches to extension, which make use of farmers' own knowledge and experience, and farmer-to-farmer learning, have been successfully introduced. Implemented by university students with local partners, the scheme attracted the participation of thousands of farmers in evaluation workshops, and 100 extension agents were trained in participatory technology development. Extension policy was changed in 16 drought-prone districts as a result. Farmer innovations have started spreading in Tigray.
- *Market improvement through low-cost information technology, Mali.*[32] People in remote drylands were at a competitive disadvantage after the removal of pan-territorial pricing, and the failure of private entrepreneurs after the public sector withdrew from marketing. The project introduced a low-cost market information network based on sending price information electronically to regional offices where it was transmitted by local radio. A majority of Mali's 11 million inhabitants now tune in to the market reports, and the private sector has increased its capacity to move grain surpluses to where they are needed.

Project failures were common in drylands 15-20 years ago, often because they were designed by outsiders, who did not involve local people in their design and execution. Much has been learnt since then. It is important that monitoring data should be collected on projects so that successes can be identified.

7. Private Investment Unaffordable? Incentives Work

How small producers invest

The purpose of public investment in dryland development is to trigger cycles of investment in the private sector. In southern and eastern Africa, there is a large commercial producing sector, but in northern Africa an overwhelming majority of private investors are small farmers and livestock producers. It is important to release the full potential of human and social capital.

Private investments are the key to each of the 'success stories', even where public sector agencies played a major role. In Machakos, for example, more soil and water conservation was financed by private capital than was put in with project assistance. In the KCSZ, the landscape of intensive farming visible today owes more to centuries of land improvements, accomplished by small farmers with limited resources, than to the World Bank-assisted programmes in the 1980s. Such investments start small in scale, are incremental through time, and may be created by unpaid family labour and skills as well as through the agency of markets (**Box 12**). Risk, especially exposure to drought and food scarcity, can easily lead to divestment through emergency sales.

[32] Hazell,P.,et al., *op.cit.:* 47.

Box 12: Some examples of micro-investments

On the farm:	*In animals:*
clearance, enclosures,	animal pens,
tree planting and protection,	hen houses,
regular soil amendments,	tethering equipment,
storage structures,	riding gear, yokes,
wet or dry compost pits,	watering vessels and well lifting gear,
crop drying floors,	milk containers,
threshing floors,	ceremonial artifacts,
field drains,	salt cures,
erosion checks - terraces, vegetation strips, wells,	feed (fattening, or when natural fodder is
locally made tools,	scarce)
seed selection, storage and purchase	immunisation

Why small producers invest

Incentives, financial or in kind, are often offered by development projects to participants. After project support is withdrawn, its sustainability and scaling-up depend on private investment. A study commissioned by the FAO Investment Centre distinguishes project incentives (called *direct* incentives) from those which operate beyond the project beneficiaries.[33] These are called *indirect* incentives and are of two types: *variable* incentives, which act through pricing mechanisms to alter the profitability of an investment, and *enabling* incentives, which by their presence in the institutional or regulatory structure affect the strategies open to investors. Examples of the first type are levels of input subsidies, and of the second type, land tenure reform.

The context of small investors' decisions is critical. There are opportunities and constraints facing the individual investor, reflecting the enabling incentives present in the economic environment, macro-economic policies, and risk of external shocks like drought. Resources are allocated to meeting livelihood objectives (which include other things than agriculture), taking account of the costs and expected benefits (e.g., to present or future income, leisure, inheritance). Many considerations, in addition to financial returns, have a bearing on these decisions. Among them are consumption requirements, social obligations, and off-farm income opportunities. Many constraints, however, impede investment, including risk, lack of funds, soil infertility, and ignorance of markets or off-farm alternatives. Thus, natural resources are embedded in a livelihood- investment framework.

Incentives work

The 'success stories' told in the earlier sections of this paper, and the production profiles in Box 10, illustrate how investments made by small producers over many years responded to incentives or disincentives. For example:

- a policy to subsidise imported rice drove Senegalese farmers away from cereal production for the domestic market and into groundnut production for export, but the withdrawal of input subsidies and agricultural credit provoked them to divert their resources to livestock production and off-farm incomes;
- the growth of food commodity markets in northern Nigeria, and an open border policy, helped to stimulate investments in farm expansion and initiate intensification in southern Maradi;
- infrastructural development and supportive sectoral policies in Burkina Faso encouraged investment in soil and water conservation, intensification and tree protection in the Central Plateau;

[33] Knowler,D., Acharya,G., and van Rensburg,T. (1998) *Incentive systems for natural resources management: the role of indirect incentives.* Rome: FAO Investment Centre.

- urbanisation and market growth encouraged investment in education, in order to access employment opportunities in Machakos, with ultimate benefits for farm investment; and
- expanding markets for research-based maize, together subsidised fertilizers, encouraged rapid farm expansion and intensification in the dry sub-humid zone of Nigeria.

Investments, undertaken in response to economic incentives, may also affect sustainability, either of livelihoods or of ecosystem management. The direction of these effects cannot be easily predicted. For example:

- new maize increased fertilizer dependency in Nigeria, with adverse effects when subsidies were reduced;
- the move into livestock in Senegal was beneficial for soil fertility management, in so far as it is based on organic materials;
- education in Machakos could either help in financing soil and water conservation, or instead, deprive farming households of male labour.

All the evidence accords a critical role to market incentives. The observed behaviour of most dryland peoples, in particular where investment is concerned, underlines the importance they attach to increased market participation. Increased dependency on markets may not always be beneficial (for example, in having to purchase food at high prices in times of scarcity). But for most farmers and agro-pastoralists, the risks associated with isolation from markets (food scarcity, unemployment, knowledge deprivation) now outweigh those of closer involvement. This is seen to have many benefits (produce sales, supplies of food and consumables, inputs and technologies, labour exchange, information, education-based careers, remittances and investment funds).

Private investment, then, can be stimulated by public sector investments and policy. Dryland peoples respond to incentives. The evidence suggests that healthy private investment goes along with a release of human potential (knowledge, skills, technical adaptability, associational and institutional capacity, management of complex livelihoods, and social resilience in the face of uncertainty).

What kinds of incentives?

The public investments examined in India (**Box 11**), besides bringing returns directly to the public sector, would function as *enabling* incentives for private investors. In so far as they reduce market or other transaction costs, they may also act as *variable* incentives. There is plenty of evidence from Africa, too, that infrastructural improvements have enabled producers to get to market or to employment, and to improve the returns on their own investments. Educational provision enabled the Akamba of Machakos to access incomes outside the district, incomes which later helped to sustain farm investments at home. But there is some disdain for formal education in parts of West Africa, where social networks and market institutions sometimes work better at disseminating knowledge and information.

Governments can alter economic incentives through a range of macro-economic, fiscal, or sectoral measures which chiefly affect the *variable* incentives.[34] There are differences in the ways in which variable incentives work. While sectoral policies (such as input subsidies) are targeted on the agricultural sector, and have impact on producers' investment decisions, macro-economic policies (such as exchange rates) take account of other or wider political interests than those of agriculture, still less those of rural drylands. Hence, policies may work either positively or negatively for small producers in drylands. Even an incentive that is intended to benefit agricultural producers may under certain circumstances have a perverse effect on the sustainability of natural resource management. For example:

- subsidising credit for mechanising agriculture could encourage commercial producers to extend cultivation onto marginal land without proper measures for maintaining fertility;
- subsidising chemical (inorganic) fertilizers to increase their use could mask degradation in soils that calls for biological or physical treatment;
- subsidising irrigation water (by failing to charge users the full cost) can encourage waste, in turn risking waterlogging or salinization.

[34] Knowler,D. et al., *op.cit.*

Macro-economic policies are regarded as blunter instruments than sectoral ones, and their effects on small producers' decisions are indirect and hard to predict, for example the effects of changes in interest or exchange rates. The impact of 'structural adjustment' policies is also difficult to track, as the term covers several different policies. Trade liberalisation may have a different impact than withdrawing government services. As long as there is uncertainty with regard to the impact of these policies on agriculture, it remains difficult to foresee specific applications to drylands.

A way out of these dilemmas is to give more attention to working through institutions, which affects the *enabling* incentives. Among such institutions are systems or rules of land tenure, Common Pool Resources, credit institutions, decentralised government services, and research and extension systems. Few generalisations are possible, as the scope for influencing investment depends on the 'architecture' of a particular country's institutions.

8. Policy Inaction Inevitable? The Costs of Doing Nothing

A final and compelling argument for investing in drylands is the losses that will accrue to both global and national economies through policies of inaction on dryland degradation. Estimating these costs is not easy. But it is important to be able to set public sector expenditures on reducing or reversing degradation in the context of the losses being borne at both local and national levels. In answer to this challenge, a series of case studies was commissioned by the Global Mechanism of the UNCCD, and the publication of the findings is currently in hand.[35] The countries are: China, Ethiopia, Mali, Mexico, Chile, Indonesia, Rwanda and Uganda. Of these countries, the first four have dryland areas which comprise a large proportion of national territory. Some findings from two of these are selected below, in order to illustrate the scope of a quantified approach.

China

According to the Government of China, over 40% is adversely affected by wind and water erosion, loss of grazing, deforestation and salinization, and degradation is on the increase (from an additional 1,800 km^2/yr on the 1980s to 3,436 km^2/yr in the late 1990s). The most intensively affected area is the vast western region.

Official estimates of the costs of degradation for the country as a whole are US$7.738 billion in direct costs (water and wind erosion, salinization and sandstorms), which is about 4% of GDP, and US$30.952 billion in indirect costs. Another estimate divides the costs between on-site and off-site costs. The on-site costs (desertification, soil erosion, salinization and pollution) are reported to be US$11.03 billion, with an additional US$6.4 billion for the replacement of lost nutrients, and the off-site costs (mainly the loss of reservoir functions) of US$11.99 billion. These huge estimates reflect the size of the territories and populations involved.

Ethiopia

By the mid-1980s, 50% of the highland areas of Ethiopia were estimated to be significantly eroded. The costs of land degradation include:

Direct costs –

- Nutrients lost in the erosion of topsoil (based on replacement costs)
- Production lost owing to nutrient loss and soil erosion
- Forest removed
- Lost livestock carrying capacity

Indirect costs –

- Loss of environmental services
- Silting of dams and rivers
- Increased irregularity in stream flow and reduced groundwater capacity
- Loss of labour and skills owing to malnutrition, poverty, or migration

[35] Berry,L. (2003) 'Land degradation in China: its extent and impact'. 'Land degradation in Ethiopia. Its extent and impact'. *Case studies on the impact and costs of land degradation.* Rome: Global Mechanism of the CCD.

Estimates of the losses due to land degradation are mostly confined to direct costs and are highly variable, reflecting the inadequacies of the data. A World Bank study estimated yearly losses of US$106 million from nutrient removal from agricultural areas, US$23 million from forest losses, and US$10 million from the loss of livestock capacity, amounting in all to US$139 million or about 3% of agricultural GDP. Another study of multi-year (aggregated) costs estimates the losses of nutrients under wheat to amount to US$46 – 544 per ha in grain output foregone, and those of maize, US$31 - 379. Applied to all cropland in the highlands, the total multi-year losses would be US$1.674 billion.

Cautions

The authors of the studies emphasise the methodological difficulties of estimating the costs of degradation, and the limitations of the data, which must include the baseline assumptions used (**Box 13**). All of the studies show links between poverty and degradation, in particular where livelihood diversification is constrained, and with policy. The indirect costs of degradation are the least well known. An integrated framework for understanding the social, institutional and economic (as well as the environmental) linkages of degradation would contribute to better policy formation.

Scenarios of future losses vary according to their baseline and operational assumptions. The accuracy of these scenarios is less important than the stimulus provided by such estimates to formulate coherent strategies at national level to deal with land degradation.

Box 13: Improving the database for assessment of dryland degradation

Despite many efforts, the information and data on land degradation are neither sufficient nor accurate enough for supporting policy decisions. There are also methodological deficiencies, in particular with regard to the use of agreed indicators of degradation. The WSSD's *Johannesburg Plan of Implementation* called for international co-operation in improving the use of science and technology for environmental monitoring, modelling, databases and information systems. Among the initiatives being taken by international organisations are the following:

- *Africover.* A harmonised classification of land cover has been developed by FAO and UNEP and tested in 10 eastern African countries. Its utility will soon be expanded to western Africa and later to other regions of the world.
- *Land Degradation Assessment in Drylands (LADA).* This initiative adopts an holistic approach to assessing changes in the physical characteristics of land, including the context of these changes (driving forces, pressures, impacts and responses). It aims to assess the nature, extent, severity and impacts of land degradation on ecosystems, watersheds, carbon storage, and biodiversity. It also aims to build national and regional capacity to mitigate impact and promote sustainable practice.
- *Global Forestry Resources Assessment (GRFA)* includes the use remotely sensed data on vegetation cover and land use.
- *Global Land Cover (GLC).* This is a data set being developed by the European Commission using remotely sensed data supplied by international co-operation.
- *UNEP/NASA/USGS Landsat data.* These three organisations are co-operating to produce three decades (1970s, 1980s, 1990s) of high resolution satellite data for African countries. Efforts are also being made to develop institutional capacity for assessing environmental impacts and land use change.

Source: Workshop on Changes in the Sahel, Nairobi, 14-16 October, 2003. Final Report and Abstracts. Nairobi: United Nations Environment Programme

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In addition to the long-term costs of land degradation, governments of dryland countries and donors absorb the short-term costs of crisis management when food scarcities threaten large populations after drought or conflict. There are no aggregate estimates of the total costs of the Sahel Drought of the 1970s or the Ethiopian famine of the 1980s. Emergencies absorb resources which could have been invested in longer term development. If the costs of neglect are huge, so are the potential benefits.

9. A New Paradigm for Dryland Investment

A new policy landscape

The global policy environment has changed radically since the dominant approach to developing drylands took root in the movement to control 'desertification' following UNCOD in 1977. This approach took sustainable natural resource management as its aim, and saw the halting and reversing of desertification as a necessary condition. There was pressure to impose technical solutions without adequate attention being paid either to indigenous capabilities or to economic and other incentives.

Since then, the following changes have occurred:

- The endorsement of the MDGs, the Rome Declaration on Food Security (1996), and international conventions have turned the spotlight on to a rights-based approach to poverty reduction.
- Poverty reduction has become the main aim of development with the implication that policies and interventions should be targeted. Poverty Reduction Strategies require governments to focus on vulnerable groups.
- An emphasis on technology and natural resource management as the prime means of raising productivity (which it was assumed would benefit the rural poor) has given way to a broader approach including access to assets, markets, and supportive institutions.[36]
- Within an institutional framework, issues of governance, decentralisation and empowerment have emerged as powerful mediators of technical change in natural resource management.[37]
- There is increasing recognition of the complexity of rural livelihoods, in which natural resource management finds a place as one (often the most important) of several components. Assets and incomes are distributed among the components, and investment decisions take place in this framework.[38]

A retreat from agricultural sector support characterised many donors during the 1990s, but following a sanguine evaluation of experience with alternatives, there is now a renewed enthusiasm for it (see Section 1). The Pretoria Statement[39] says that

> Only improved agricultural productivity can simultaneously improve welfare among the two-thirds of all Africans who work primarily in agriculture as well as the urban poor, who spend over 60% of their budget on food staples.

The background to these changes has been a rapidly dynamic global economic environment, with increasingly concentrated market power and rapidly evolving biological, information and communication technologies. It is urgent that development policy should give dryland peoples the best prospects possible, in a world of liberalised trade, decentralised government, and de-restricted private initiative.

People at the centre: realising potentials

In the past, policies focused on the presumed limitations of the natural resource base, rather than on the people, their knowledge, skills and capacity for innovation. Although poor in natural, financial and physical assets, they possess substantial human and social capital (as stated in the previous Section). The strength of these internal resources is now better understood by policy makers. The cases described in the boxes in this paper provide strong support for an emerging truth: namely that drylands, like other environments, should be seen as stage and scenery; the greater importance being with the players and their ideas of what can done with the resources at hand.[40]

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[36] IFAD (2001) *Rural poverty 2001. The challenge of ending rural poverty.* Rome: International Fund for Agricultural Development.

[37] USAID (2002) *Nature, wealth and power.* Washington,D.C.: United States Agency for International Development.

[38] Ellis,F. (2000) *Rural livelihoods and diversity in developing countries.* Oxford University Press.

[39] *Pretoria Statement on the Future of African Agriculture, 2003.* Pretoria: Participants of the International Conference on Successes in African Agriculture – Building for the Future.

[40] USAID (2002) *Nature, wealth and power. Emerging best practice for revitalising rural Africa.* Washington, D.C.: USAID; Anderson,J. (with 18 others, 2004) *Chance, change and choice in Africa's drylands. A new perspective on policy priorities.* Participants of the Workshop on Development Assistance in the African Drylands, Durban, August, 2003.

Drylands have, however, fallen behind more favoured areas in the development process. While this situation is a cause for concern, it also offers an opportunity. As the Indian data suggest, comparatively rapid gains may be available from strategic public sector investments, working from a low baseline. This ought to be attractive to governments and potential donors alike, who need to mobilise the unrealised potential of these uncertain and risky environments. But making a difference does not need to depend on costly interventions by the public sector. Policy measures may have greater impact.

Priority areas, based on the reasoning above and on two recent policy papers[41] are:

- *Develop improved investment incentives.* In line with the argument above, urgent reviews of incentive frameworks are needed which take account of the specific circumstances of dryland areas within different states. The purpose of improving incentives is to widen the range of opportunities (across all sectors) for dryland people, remove barriers to investment and participation in economic activity, and secure the benefits of investment. The place of natural resource management in an incentive framework for dryland areas will be based on a negotiated alignment of the local communities' priorities with a long term strategy for sustainable ecosystem management.
- *Unleashing individual and organisational capacity.* Authority and functions in rural areas are changing as decentralisation programmes are implemented. In drylands, decisions in these matters may have implications for the sustainability of ecosystem management. It is important that such decisions are made at a level that ensures implementation and responsibility, through local empowerment. Rural organisations (for example, credit and producers' associations, market institutions) deserve assistance, as they create economies of scale, and raise economic returns to poor people. A voice for local people should be promoted through capacity-building in local languages, strengthening interaction with higher levels, downward accountability and strengthening processes of negotiation.
- *Sharing knowledge and information in new partnerships and improved management systems.* Local knowledge should be valued as well as science-based knowledge, and research should be owned by local communities in new partnerships with institutions. Technological priorities should reflect community and family livelihood needs as well as the scientific objectives identified by the research institutions, which are still important providers of a range of technical options. Social learning, innovation, farmer-to-farmer exchange, and adaptive management need equal emphasis with conventional capacity building through training.
- *Developing the capacity, confidence and competence of service providers.* Government extension and research agencies, NGOs and local authorities should respond to the expressed needs of small producers, and not push them towards technologies that are inappropriate for their circumstances. Institutional arrangements for interacting with local people, and for taking on new functions under decentralisation programmes, should be strengthened. The weight given to local experience should be increased, and the content of training programmes improved (to cover more than a few simple extension messages), and to ensure continuity.
- *Diversifying incomes and securing linkages.* Income diversification and rural-urban linkages should be promoted by improving road infrastructure, market and technology information networks, postal and savings services. It must be recognised that dryland people have both the right and the need to diversify out of agriculture. Commercial investment (which is low in most drylands) can be attracted by fiscal measures, for example in small towns or places with tourism potential.

New technical and economic opportunities

Small producers live in varying circumstances, and need a 'menu' of technical and economic options from which to choose. This is a challenge to research and extension systems, too long influenced by a search for 'miracle' technologies and simple, universal messages. However, new opportunities abound, and key elements in a science-technology and economic agenda for dryland agriculture include the following:[42]

[41] *Ibid.*

[42] ICRISAT (2003) *Symposium on building sustainable agriculture systems in the drylands, Niamey, December, 2003. Recommendations.* Sadore,Niamey: International Crop Research Institute for the Semi-Arid Tropics; *Pretoria Statement (ibid.)*

- *Crop breeding* must meet a need for diversification, in response to falling prices for traditional market crops, as well as supporting food security through traditional staples. The complexity and variability of farmers' circumstances in the drylands should be recognised, and technical packages developed in participation with farmers and other stakeholders, taking account of needs, costs and benefits. There have been breeding successes (e.g., with maize), and others should be sought. New biological and other technologies should be exploited.
- *Soil health* is a priority. Ecological interactions need to be understood better. Cost-effective fertilizer applications (e.g., using micro-doses), the integrated use of organic and inorganic fertilizers, and crop-livestock integration need more development.
- *Trees* should be integrated with crop production, local biodiversity protected, and promising new species promoted.
- *Integrated ecosystem management* provides an holistic context in which technical solutions should be sought.
- *Marketing systems* need to develop rapidly, in order to improve the competitiveness of small producers. There are many directions for such improvements: for example, more efficient aggregating and transport of output, better marketing information for producers, more collaboration among producers and the involvement of producers' associations in quality control. The management of supply chains (vertical farmer-to-market co-ordination) should involve the producers, as well as the traditional focus on production. *Extension systems* should broaden their scope from promoting research-based messages to advisory and participatory roles, including testing and up-scaling farmers' own experimental successes, for example in soil and water conservation.
- *Regional cooperation* in trade and agricultural technology is especially relevant to drylands, which often straddle borders. Harmonisation of trade regulations should recognise the informal interaction which already takes place, and information exchange should be promoted. For example, regional co-operation in sharing new biological technologies would offer synergies. NEPAD provides a suitable framework.

Research-policy dialogue needs to be strengthened, as macro-economic and fiscal policies, institutional legislation (such as on land tenure) and enabling measures (such as infrastructure) can make or break technology development and promotion.

Why invest in drylands?

The cases reported in this paper argue that investment, in either the public or the private sector, can pay. It has also been argued that public investments, strategically placed, can strengthen incentives for private investments by small producers, particularly those linking them better with market opportunities. Thus a dual strategy for the state is advocated, which consists in strategic *public investments* (for example, in rural roads), together with *policy measures* (for example, strengthening institutions for local management of natural resources) which are designed to *enable* or to *vary* returns to private investment. There is an increasing body of evidence that dryland people respond vigorously to economic incentives. Poverty is often assumed to block private investment, either in more productive technologies or in sustainable natural resource management. The evidence shows, however, that in certain areas there have been enough private, small-scale investments to transform entire landscapes over a period of time.

Much poverty in drylands is the result of asset dispersal during food scarcities. This is well documented with respect to livestock producers, who lose many animals from forced sales or mortality. Farmers too may have to sell capital equipment, inputs, consumables, land, and even houses, when their normal strategies of selling labour or skills fail. Vulnerability to asset loss perpetuates poverty, and widens the gap between those who sustain their productive capacity, and accumulate assets, and those who fail to do so. So protecting poor peoples' painfully accumulated investments offers an additional challenge to drylands policy. But there is a capacity to manage such risk, as the landscape of any densely-populated, long-settled dryland will show.

Given acceptable returns, investment generates confidence in economic growth at the grass-roots. Such confidence is a pre-condition for further investment. It also contributes less tangible benefits, such as positive evaluations of education, strengthened social capital, and local empowerment in decision making and governance, which also offer long-term gains to the community. Some drylands have made impressive progress in these respects, despite severe constraints.

Finally, the argument of this paper is that the best protection against unsustainable ecosystem management is not to exclude people, but rather to promote investments in sustainable and productive land use practices. Added value is the best defence against mining natural capital, provided that the enjoyment of heritable benefits is assured.