iied

International Institute for Environment and Development

Sustainable Agriculture and Rural Livelihoods Programme

Gatekeeper Series no. 94

Poverty and Systems Research in the Drylands

Michael Mortimore, Bill Adams and Frances Harris

2000

Submitting papers to the *Gatekeeper Series*

We welcome contributions to the *Gatekeeper Series* from researchers and practitioners alike. The Series addresses issues of interest to policy makers relating to the broad area of sustainable agriculture and resource management. *Gatekeepers* aim to provide an informed briefing on key policy issues in a readable, digestible form for an institutional and individual readership largely comprising policy and decision-makers within aid agencies, national governments, NGOs and research institutes throughout the world. In addition to this primary audience, *Gatekeepers* are increasingly requested by educators in tertiary education institutions, particularly in the South, for use as course or seminar discussion material.

Submitted material must be of interest to a wide audience and may combine an examination of broad policy questions with the presentation of specific case studies. The paper should conclude with a discussion of the policy implications of the work presented.

Style

Gatekeepers must be short, easy to read and make simple, concise points.

- Use short sentences and paragraphs.
- Keep language simple.
- Use the active voice.
- Use a variety of presentation approaches (text, tables, boxes, figures/ illustrations, bullet points).
- Length: maximum 5,000 words

Abstract

Authors should also include a brief summary of their paper – no longer than 450 words.

Editorial process

Please send two hard copies of your paper. Papers are reviewed by the editorial committee and comments sent back to authors. Authors may be requested to make changes to papers accepted for publication. Any subsequent editorial amendments will be undertaken in consultation with the author. Assistance with editing and language can be provided where appropriate.

Papers or correspondence should be addressed to:

Gatekeeper Editor
Sustainable Agriculture and Rural Livelihoods Programme
IIED, 3 Endsleigh Street, London WC1H ODD, UK
Tel:(+44 020) 7388 2117; Fax: (+44 020) 7388 2826; e-mail: sustag@iied.org

The Gatekeeper Series produced by IIED's Sustainable Agriculture and Rural Livelihoods Programme aims to highlight key topics in the field of sustainable agriculture and resource management. Each paper reviews a selected issue of contemporary importance and draws preliminary conclusions for development that are particularly relevant for policymakers, researchers and planners. References are provided to important sources and background material. The Series is published three times a year – in April, August and December – and is supported by the Swedish International Development Cooperation Agency (Sida).

The views expressed in this paper are those of the author(s), and do not necessarily represent those of the International Institute for Environment and Development (IIED), The Swedish International Development Cooperation Agency (Sida), or any of their partners.

Michael Mortimore is co-ordinating collaborative studies of long term change in natural resource management and livelihood strategies in dryland areas of Kenya, Senegal, Niger and northern Nigeria, and has written or co-authored several books on African smallholders.

Bill Adams lectures in geography at Cambridge University and has written books on development, conservation and nature management in Africa and in Britain, and researched northern Nigerian farmers.

Frances Harris has researched nutrient cycling on small farms in northern Nigeria, has carried out short assignments in other African countries, Brazil and India, and is presently based at the University of Durham.

The authors can be contacted as follows:

Frances Harris, Centre of Research on Development, University of Durham, Science Laboratories, South Road, Durham DH1 3LE, UK. Email: frances.harris@durham.ac.uk

WM Adams, Department of Geography, University of Cambridge, Downing Place, Cambridge, CB2 3EN, UK. Email: wa12@hermes.ac.uk

Michael Mortimore, Drylands Research, 17 Market Square, Crewkerne TA18 7LG, UK. Email: mikemortimore@compuserve.com

2000

Executive Summary

The specific dimensions of poverty in the drylands, whether Africa or India, have eluded development attempts focused narrowly on productivity increases. The reality of dryland livelihoods reflects the challenge of constraint management. Droughts or resource degradation depress agricultural incomes and raise the gains of diversification, with drylands people engaging more in urban or international product and labour markets. Thus, livelihood options combine managing natural resources with off-farm options.

In this paper we call for a holistic or systems approach to research linking natural resource management with livelihoods in the drylands, which is a departure from the sectoral or disciplinary frameworks which were formerly traditional in development practice. Research needs to situate natural resources, given the peculiar constraints of the drylands, within a framework of livelihood options, and locate points of entry for developmental initiatives. A series of projects carried out in dryland systems in the Nigerian Sahel in the 1990s suggested some critical targets for research. This paper reflects on this work in the broader context of natural resource management and rural livelihoods in the dryland regions of tropical Africa and South Asia. The proposed approach goes beyond existing models such as Farming Systems Research, Farmer Participatory Research, and the Sustainable Livelihoods approach, towards one tailor-made for drylands communities in which the critical constraints in natural resources (NR) drive economic diversification while creating complex linkages between NR and poverty, linkages which must be understood if entry points for development initiatives are to be correctly identified. The focus of this approach is the *management* of constraints and opportunities by smallholders.

Ten principles are proposed for inclusion in a policy framework:

1. Countering variability, especially in the complex interaction between rainfall and labour management
2. Facilitating the flexible use of labour
3. Integrating crops and livestock as a means of supporting increased and sustainable productivity
4. Promoting farmers' own attempts at seeking diversity
5. Enabling agricultural intensification
6. Promoting markets
7. Supporting multi-sectoral objectives
8. Alleviating poverty among vulnerable households.
9. Alleviating poverty among women.
10. Reducing the impact of sickness

POVERTY AND SYSTEMS RESEARCH IN THE DRYLANDS[1]

Michael Mortimore, Bill Adams and Frances Harris

Introduction

Elimination of poverty, though always an aim of development assistance, has recently been brought more sharply into focus in the UK's development policy (DFID, 1997). Many lessons have been learnt (both negative and positive) from three or more decades of research and development assistance in poor countries. For the research community, there is now a fresh emphasis on delivering outputs which have verifiable impacts on policy, target institutions or disadvantaged social groups. It is apparent that neither macro-economic improvements in poor countries, nor productivity enhancing technologies in agriculture, necessarily deliver better living conditions to the poor and marginalised. Something more is required. More focused and tightly managed research is needed, both at the fundamental and applied levels. Research designs, through various forms of community participation or collaboration, need to take better account of the real-life situations of the proposed beneficiaries, the poor households themselves. The multi-sectoral dimensions of household and individual livelihood strategies demand an holistic and systems approach (DFID/NRSP, 1999). It is a premise of this paper that outcomes from new knowledge which can really benefit the poor must depend on sound analytical method.

Livelihoods in the drylands

Smallholders who live in the tropical drylands are unable to escape from the impact of two fundamental properties of their ecosystems: they are dry, and their rainfall is unreliable. Leaving aside the arid zone, where rainfed farming is impossible, the heart of the drylands is the semi-arid zone, which receives from 250 to 1,000 mm of rainfall each year, and may have one or two short rainy seasons which provide a growing period of 75-179 days. There is little or no rain for five months or more. Domestic animals lose weight and (in drier years) may starve. They may have to be watered from wells, consuming much labour. Rainfed farming is episodic, with periods of intense and exhausting work separated by periods of relative inactivity. Bio-productive potentials are low relative to humid and sub-humid regions.

---

1 This paper draws directly on the results of Research Project R 7093 (Relevance of Nigerian farmers' responses to dryland farming systems in southern Africa and India), *Semi-Arid Production Systems, Natural Resources Systems Programme, Department for International Development (DFID). DFID can accept no responsibility for any information provided or views expressed.*

Rainfall variability introduces an element of risk into almost all life-supporting activity, most especially rainfed crop production. The impact of variability, which in practice usually means vulnerability to drought, increases with aridity. While it can be measured (in probability terms) and this enables an assessment of risk and returns in agriculture, no-one can predict the time or intensity of droughts, which are matters of life and death for small-scale resource managers. The incorporation of measures to cope with rainfall variability into development policy or projects is extremely difficult.

Sustainable management of natural resources (NRs) is a condition for enhancing incomes based on primary production, in view of the fact that in nearly all drylands, land and bio-productive resources are becoming (or have long been) scarce. However, drylands people are engaging more in urban or international product and labour markets. Droughts or resource degradation depress agricultural incomes and raise the gains of diversification. Thus, livelihood options combine managing natural resources with off-farm options. Households and individuals need to strengthen, improve, and diversify their available options, and to protect their cumulative investments.

However, while diversification has always been central to dryland livelihood systems, it has *not* been central to either research or development interventions in those systems. These have tended to embrace a *sectoral* approach. Sectoral studies of farming or livestock do not advance an understanding of the relationships linking diversification with natural resource management (NRM), which may be either complementary (through accessing external capital, new knowledge, and savings) or competitive (through labour withdrawal and export of rural capital).

The specific dimensions of poverty in the drylands underline the fact that the essence of the challenge is *constraint management*. In everyday living, decisions are constantly made about the allocation of scarce resources (labour, capital, rights of access to land, water and bioproductive resources) to a limited range of options (determined by rainfall, fertility, markets, knowledge), and the outcome determines the economic trajectory of a particular household. This *management* focus is distinct from the traditional development foci of *technical improvement* and *economic profit*. The qualified success (or, often, failure) of external attempts to transform systems through new and profitable technologies suggests that a management focus is potentially helpful.

In view of these reflections, we call for a holistic or *systemic* approach to research in natural resources, which is a departure from the sectoral or disciplinary frameworks which were formerly traditional in development practice and are still strongly reflected in research structures in many countries (India, for example). Many lessons (both positive and negative) have been learnt from such research. However there have been disappointments in applying it, more especially in the drylands where a Green Revolution has failed to materialise.

Research needs to situate natural resources, given the peculiar constraints of the drylands, within a framework of livelihood options, and locate points of entry for developmental initiatives. A series of projects carried out in dryland systems in the Nigerian Sahel in the 1990s (Mortimore, 1998; Mortimore and Adams, 1999; Harris, 1998, 1999) suggested some critical targets for research. This paper reflects on this work in the broader context of natural resource management and rural livelihoods in the dryland regions of tropical Africa and South Asia.

Research on rural livelihood systems

Rural livelihood systems in drylands (which usually include a mix of NR-based, non-NR based and migrant incomes) have, by their persistence over several decades, demonstrated a *resilience* which runs counter to some predictions of imminent irreversible degradation or collapse (Haswell, 1975; Walker and Ryan, 1990; Tiffen *et al.*, 1994; Mortimore, 1998). Many Indian villages have been managing natural resources for centuries, even millennia. Even in areas of pioneer settlement, most systems have been maintained for periods of time exceeding several cultivation/fallow cycles. Yet most attempts at developing these systems have been essentially ahistorical, and based on a 'prescriptive-diagnostic' mode which assumed a necessity for technology transfer. Our studies in Nigeria suggest significant limits to the utility of such approaches.

The persistence of rural livelihood systems is grounded in local technical knowledge about natural resource management. The farmer knows many aspects of his/her local environment better than the visiting expert. A range of technological and management options is known in the community and drawn upon by individuals. Before any attempt is made to manipulate the technological environment, there is a need, which has often been ignored, to inventory and evaluate existing options.

Furthermore, local knowledge is not static, but grows as new knowledge enters the system through promotions, project interventions, media/education/extension, experimentation, or exchange. It is adaptive to change. After many decades of development farmers may also have superior knowledge of earlier technical interventions: the farmer remembers, whereas the expert may not have access to his predecessor's paperwork.

However, knowledge exists only in a social context and access to it is unequal and subject to differential resource endowments and social determinants. It seems likely that for many resource users - in India, at least - access to knowledge is in excess of the capacity of farmers to use it, owing to the constraints under which they operate: 'They have ideas of what to do, but they are unable to do it'. Their economic trajectories, therefore, are determined less by their knowledge (or lack of it) than by their success in managing such constraints. The same may be said of the trajectories of their natural resource systems (whether or not they degrade their land, lower their water table, impoverish their biodiversity, etc.).

A divergence between indigenous and scientists' perceptions of what can be achieved can arise from a different prioritisation of needs; a different valuation of outputs (eg., yield of new varieties versus taste or cooking properties); labour scarcities; negative side-effects of new practices; or (as claimed by some), different time-discounting rates. Such divergence leads to selective adoption, modification, socially discriminatory uptake, early abandonment or plain rejection of offered technologies or management modes. Some of these disappointments are due to the scientist's assumption that capacity is in excess of knowledge: 'They only need to be told what to do, and they can do it'. For example, a labour surplus has often been assumed where none existed. This technological approach ignores the realities of constraint management by poor families.

The potential for technically based interventions varies across the world's drylands. In India, a diverse bank of (station-) proven technologies for dryland farming and conservation has grown over three decades from massive investment in research, with the strategic objective of doing for the drylands what the Green Revolution did for the irrigated areas (CRIDA, 1997). Market growth and diversification offer niches for a wide range of specialised dryland products. India's dilemma is that its research-based technologies have not yet fully achieved the transformation sought in dryland livelihoods. In dryland Africa, on the other hand, there are strategic gaps in the technologies on offer to farmers, more especially in the Sahel, and markets are less developed and less diverse, though urbanisation is changing this in some areas. Conservation technologies are available but not yet very widely applied, except in certain localities or project areas.

There is clearly still an important role for the invention and adaptation of new technologies, although the urgency of, and priorities for, such work vary from place to place. It is now accepted wisdom, in principle, if not everywhere in practice, that research should be participatory and on-farm and not carried out solely on research stations. Participatory research and development involves rural people in the design, execution and application of trials or experiments, most often in crop and agronomy research. Such methods are better able to accommodate the realities of the natural resource system. However, the rhetoric of participation may not necessarily reflect a genuine transfer of ownership. In trials in farmers' fields, for example, the scientist can merely carry out an experimental plan in a different setting, transforming by intervention the very constraints which have earlier obstructed change. The incentives which are intentionally or unintentionally offered for participation may distort the evaluation of what is on offer. Expectations may even distort peoples' prioritisation of their needs, where project interventions with large resources are involved.

In the question-and-answer mode commonly used for 'participatory' exercises and in compiling agendas for research or interventions at expert workshops, there is a built-in bias towards a diagnostic-prescriptive mode of analysis. The roots of such an approach, at least in Africa, go back to the earliest encounters between scientists/professionals of European extraction and the seeming incoherence and complexity of indige-

nous farming systems. This led to directive interventions of the kind so common in colonial conservation programmes in Africa. Negative evaluations of African farming systems arose in many instances from a failure to appreciate the nature of the constraints under which farmers worked. Where labour is limiting and land abundant, for example, labour-intensive methods of raising output per hectare are unlikely to make sense to farmers. A problem-seeking approach inevitably focuses attention on what the scientist (even if commissioned by local people) can do to turn the problem around. The direction of knowledge flow is 'downwards', and 'development' is dominated by the transfer of technology.

The logic suggested here points in a different direction: that attention should be placed on an 'upward' flow of local capability which needs to be enhanced by increased capacity and enlarged choice. A systems approach in research on rural livelihoods is needed for the reason that farmers, livestock producers, and other livelihood seekers make decisions about resource management in the context of their whole system and not on the basis of its components alone. Simplistically, the science needs to be brought into the system, rather than the system into the science. This poses a challenge for the scientist, who must learn to begin with the end-user and apply his knowledge to his/her system, rather than working towards a scientific transformation of the system along externally determined lines. While this challenge is increasingly recognised, it is complex to meet.

The effort to 'develop' a system is necessarily multi-faceted and time-dependent. Systems research is necessary at the *inception* of an initiative, in order to understand the system in question; during *implementation*, in order to adapt project policy to changes which are occurring; and during impact *assessment*, to take account of indirect as well as direct costs and benefits. The approach described briefly in this paper provides one model which, tried in the Nigerian Sahel, addresses a suite of sub-systems also commonly encountered in Indian and southern African drylands. It is by no means the only possible model.

Themes for drylands systems research: lessons from Nigeria

Change in the drylands is apt to be rapid and emanates both from forces in the social, natural and economic environment, and from the dynamic of natural resource systems themselves (Table 1).

Such changes occur under a canopy of policy (whether implemented or not) which affects the economic opportunities available (via prices, legislation, interventions, etc.) and is itself subject to a political dynamic. Given such a context of change, studies in north-east Nigeria suggest that a trinity of properties is desirable in a dryland livelihood system (Mortimore and Adams, 1999):

Table 1. Some sources of change for dryland communities

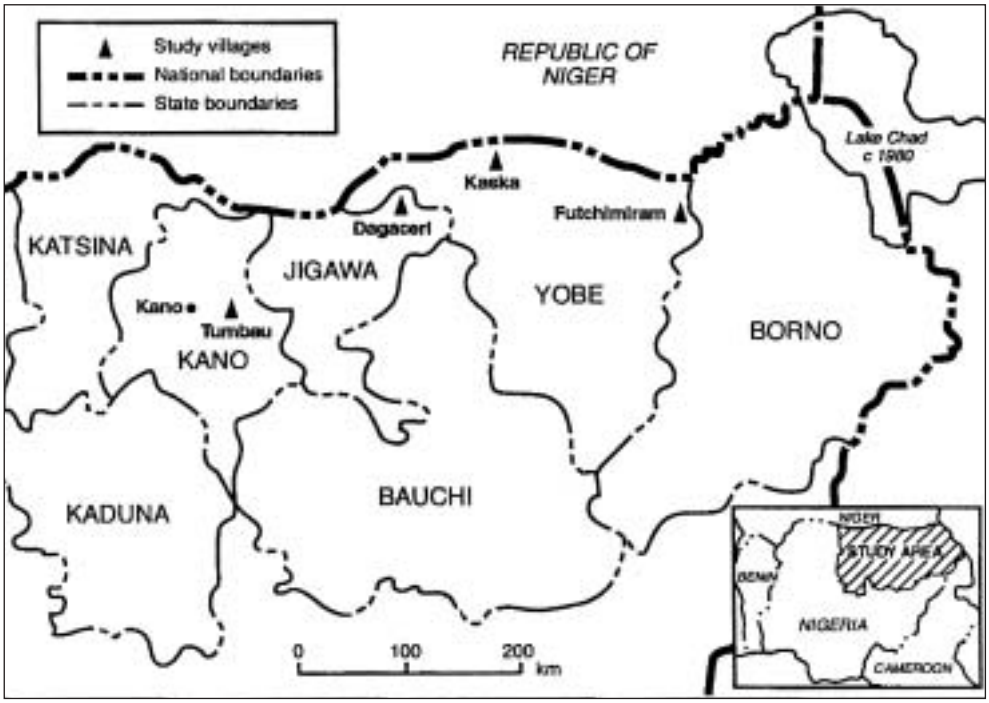
Social changes	Environmental changes	Changes in management
Demographic transition to lower human fertility	*Climate change* to lower or more variable rainfall	*Land use/ cover change* to more farmland, towns, etc.
AIDS and other disease factors	*Soil fertility decline* under cultivation or erosion	*Privatisation* of natural resources
Labour scarcity and increased cost of hiring	*Land scarcity* in densely populated or alienated areas	*Increased farm* and labour inputs, intensification, crop-livestock integration
Urbanisation and growth in off-farm income opportunities	*Loss of biodiversity* either natural or cultivated	*Increased migration* and income diversification

- flexibility (for example, in adjusting farm labour inputs to variable rainfall within the growing season);
- adaptability (for example, in switching between crops or livelihood options from year to year); and
- diversity (increasing the 'menu' of choices available to households or individuals).

These studies aimed to situate the smallholders' management of natural resources within a framework of livelihood strategies and decisions. To do so, four communities (Figure 1) living in a range of conditions - ecological (rainfall), demographic (population density) and economic (market access) - engaged with researchers over four successive farming years (May-December, 1993-96). The farming systems were characterised (Chiroma, 1996; Ibrahim, 1996; Mohammed, 1996; Yusuf, 1996). Analytical studies were carried out of the farmers' management of nutrient cycling (Harris, 1998; 1999). Parallel profiles were constructed of land use and vegetation change (Turner, 1997), soil fertility management, biodiversity management, land tenure and natural resource access, crop and livestock production technologies, and off-farm and migrant incomes. By means of quantitative monitoring, all were linked with the critical management variable of labour, which includes the role of women and children (Mortimore and Adams, 1999). This work was carried out by a small team of geographers representing several sub-disciplinary specialisms from Cambridge University and Bayero University, Kano.

Our work supports the view that in dryland West Africa, increasing rural population densities, increasing market production of food crops, improving national food sufficiency, and intensifying interaction between town and country are co-occurring (Snrech *et al.*, 1994). Intensive farming systems in areas of high rural population density have not failed, as often predicted. Rising land prices, and 'scrambles' for farms, even in the driest areas, indicate that rural people (and many urban ones also) have not written off

Figure 1. The study area



their productive potential. An adaptive policy framework which aims to support rather than direct, enable rather than control, positive change in a Sahelian environment, should be the aim, and it needs to be based on empirical analysis, and be less reliant on ill-researched degradation scenarios.

Based on the Nigerian research, ten principles are proposed for inclusion in a policy framework, which we believe are also applicable in the Indian or southern African context:

(1) *Countering variability.* The complex interaction between rainfall and labour management within the season is illustrated in Box 1. No two years are exactly the same. Farmers must therefore adroitly negotiate the risks of lost output which such variability brings. Variability between seasons threatens not only output, but also savings and farm investments. The incremental accumulation of such investments, which are a determinant of bio-productive potential on-farm and of incomes off the farm, is a fragile process in drylands, yet essential for the elimination of poverty. Development interventions tend to address average conditions. The management of variability has proved a difficult target, for example research on rainfall 'response farming' in Kenya (Stewart, 1991) failed to generate outputs of immediate applicability on small farms. There have been many calls for ways to support or improve indigenous insurance systems (e.g., Mortimore, 1989).

Box 1. Rainfall and farm labour use in Tumbau, Nigeria, 1996

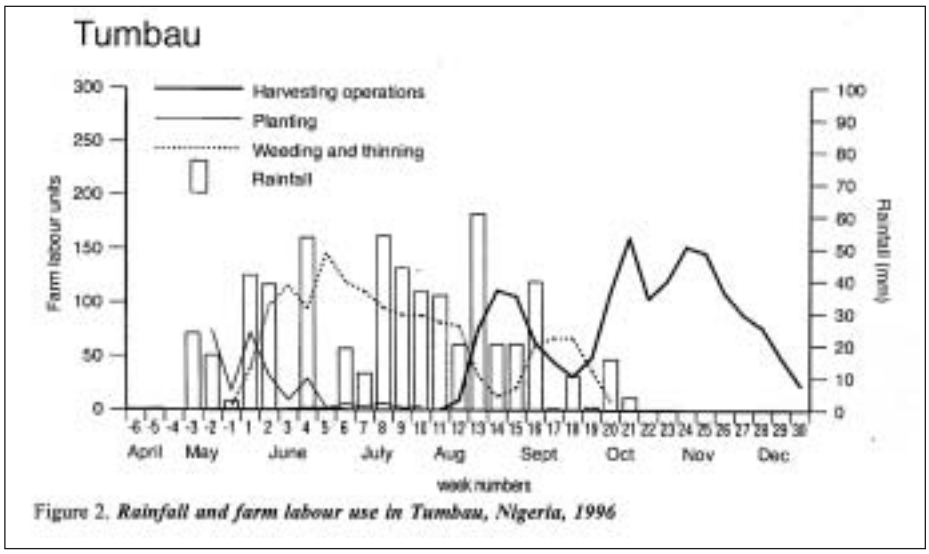


Figure 2. ***Rainfall and farm labour use in Tumbau, Nigeria, 1996***

Labour allocations to the three major farming operations (planting, weeding and harvesting), fluctuate during the season (according to rain-dependent growth cycles of the crops) and between years (in every year, the rainfall distribution is different). Mismanagement incurs a loss of yield; yet in drought, much farm labour is wasted.

In this example, planting work peaked very early; weeding was done three times during the season. Harvesting was divided into two peaks, first early millet and cowpeas, and second sorghum, late cowpeas and groundnuts. The all-important weeding suppressed all other labour tasks; and competed directly with harvesting work later in the season. The opportunity costs of different kinds of farm work are thus constantly held in view as farmers negotiate their way through the growing season.

Source: Mortimore and Adams (1999)

Similarly, in the plains of north-western India a graduated rainfall regime, culminating in the Thar Desert, is strongly analogous to that of the Sahel and carries similar levels of risk. However, different crops and technical arrangements (for example, more use of animal traction) configure the labour equation. In the dryland areas of central and southern India, rainfall variability is widely cited as the primary constraint facing the very diversified farming systems. Smallholders in Southern African drylands also occupy differentiated agro-ecological zones which call for location-specific strategies and technologies (for example, in southern Malawi, draft animals are very scarce). There are no comparative studies of labour management in response to variable rainfall across these three regions.

(2) *Facilitating the flexible use of labour.* Short-season cropping systems have sharply peaked labour regimes. The higher the percentage of available labour that is necessary, the less flexibility is possible. Longer-season systems permit the sequencing of multiple operations, and greater flexibility. Labour-saving technologies are only useful for a short time each year. Consequently labour hiring institutions assume an increasing role in differentiating between poor and wealthy farmers. Livestock are demanding of labour especially in the cropping season. Increasing opportunity costs of farm labour vis a vis migrant employment must exacerbate labour management conflicts. Thus finding solutions to labour bottlenecks (Box 2) needs to be put into an explicitly systemic context. That is to say, there are unlikely to be simple solutions applicable everywhere. Most northern Nigerian farmers seek to save labour by owning or hiring ploughs, drawn by bulls, for ridging both before sowing and in early inter-row weeding. Mechanisation of late weeding is not possible owing to the height of the grain (sorghum or millet) and the practice of inter-cropping with low growing or spreading crops (groundnuts or cowpeas). In India, however, plough technology is ancient.

Box 2. Labour use in farming and livestock work, Tumbau, 1996

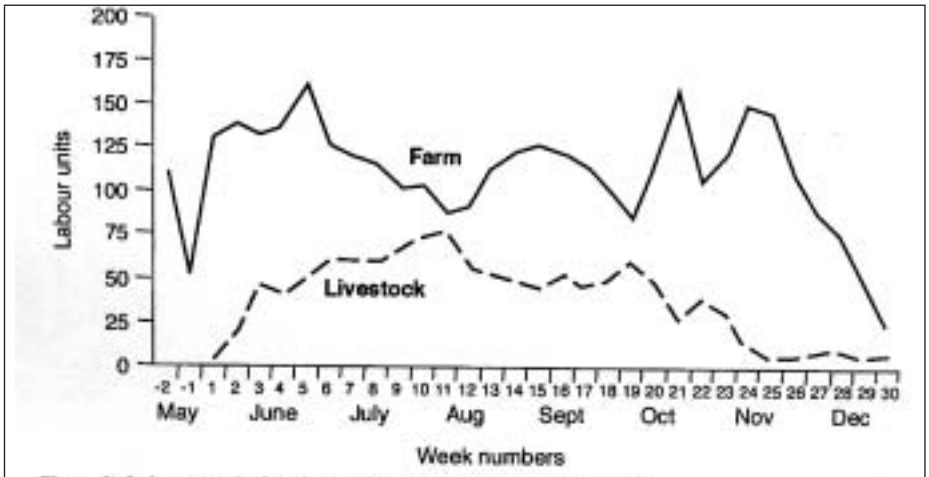


Figure 3. *Labour use in farming and livestock work, Tumbau, 1996*

Where farming is extensive, labour allocated to tending animals during the farming season is low, because a few small children can safely take the animals to graze on common pastures during the day, while everyone else works on the farms. But where farming is intensive, as in Tumbau, there are no common pastures, and sharing the supervision of grazing animals is impossible. So the animals are stall-fed on weeds and hedge-cuttings which are laboriously gathered by each family every day. Their manure is composted and redistributed to the farms (Harris, 1998; Yusuf, 1996). The proportion of the labour force that is tied up with animal care is high relative to farm work.

Source: Mortimore and Adams (1999)

(3) *Integrating crops and livestock.* Crop-livestock integration is often promoted as a way of increasing productivity, with specific benefits for poor households. However many such promotions have had only limited uptake, because the necessary preconditions of a scarcity of cultivable land, an adequate supply of labour, and of capital or breeding resources are absent (Box 3). Meanwhile, the northern

Box 3. Cycling nutrients in high and lower intensity systems

The technologies of nutrient management under conditions of increasing human and/or livestock population density, and their application, determine the sustainability of farming systems. The dryland farmers of Nigeria have insufficient nutrients, and the management of supply (including biomass production, livestock ownership, manuring or composting practice, and purchases of inorganic fertilisers) is critical. Financial resources matter; also, the more labour available, the more time can be invested in repetitive tasks like manuring, multiple weeding, ridging, browse and fodder collection and residue harvesting. Nutrient balances can thus be maintained under intensive farming, with relatively abundant labour and high livestock densities, whereas less intensive (land-constrained) systems are less sustainable.

For example, in a farming system with a residential population density of 223/km2 and a mean farming season rainfall of 571 mm, the key to nutrient cycling is the integration of crop with livestock production. Small ruminants consume residues, including sorghum stalks and haulms of grain legumes, which are high quality fodder. Legumes contribute nitrogen to the soil through biological nitrogen fixation. Some of the nitrogen fixed by these legumes is consumed by livestock and converted to manure, which is mixed with compound waste and carried back to the fields. Sold grains (cowpeas and groundnuts) help finance small inputs of inorganic fertilisers. Cations and micronutrients are added to the system from the Harmattan dust that is deposited on fields in the dry season. Over 85% of the surface is cultivated every year, yet as well as supporting livestock the farmers achieve yields, on their multi-cropped farms, of about 280 kg/ha of grain legumes, 1.1 t/ha of cereal grain, and 1.8 t/ha of fodder (measurements in 1993 and 1994). Nutrients (nitrogen, phosphorus, potassium, calcium, and magnesium) were approximately in balance on three farms in Tumbau in 1993; in 1994 (a year with higher rainfall and greater nutrient uptake), nitrogen was in deficit on two of the three farms (Harris, 1998).

In a farming system having a lower population density of 43/km2, and a mean farming season rainfall of 360mm, nutrient stocks are maintained by transfers from rangeland and fallows, through grazing animals which deposit manure on cultivated fields or in pens, where it is mixed with waste and carried out later. Inorganic fertiliser is uneconomic at prevailing prices, and infrequently used. The Harmattan also affects this area. Only 55% of the surface is farmed (including both cultivated and short fallow land). Yields are lower than in the first system. A study of nutrient balances on six farms operating under contrasting management strategies indicated that those farmers relying on crop-livestock integration achieved positive nutrient balances for nitrogen and phosphorus. However, those relying on fallowing and less intensive farming methods and who had few or no livestock had significant nitrogen deficits (Harris, 1999).

Nigerian systems studied have autonomously integrated cattle and/or small ruminants with crop and fodder production on manured farms; and farm traction (both for ploughs and carts) merges with livestock fattening for a growing meat market. Thus livestock may *both* enhance output per hectare and increase incomes. In Nigeria, where livestock and human population densities are significantly correlated (Bourn and Wint, 1994), and every family aspires to own animals, there are strong economic forces driving integration.

However, the crop-livestock integration pathways achieved in west and southern Africa, and in north-west and central-southern India differ significantly, and in at least one important farming system, the maize system of southern Malawi, they have failed (a majority of households own no livestock). A comparative and system-specific framework for research on animal husbandry by small farmers can link the ancient achievements of high livestock densities and well-integrated systems in India with the strong dynamics of land use change and animal husbandry in the Sahel, and to the southern African systems, some of them distorted by historic patterns of land alienation. Such an effort may explain or rectify the variable success of external attempts to promote integration.

A contrast between the persistence of India's farming systems and the dynamics observed in Africa raises obvious questions for research. The role of inorganic fertilisation in dryland farming systems - advocated by many as the only route (integrated fertility management) to sustained productivity in Africa - is inconsistent, as organic alternatives vary from system to system, and subsidy policies shift through time. A systemic perspective can expose the interaction of external (economic and political) variables with the constraints within the system or farm.

(4) *Promoting diversity*. Much research confirms that diversity is sought by rural people, reducing risk and contradicting Green Revolution orthodoxy. Using smallholders' own selective, experimental, adaptive and combinative skills to develop technical, management, or genetic solutions (Box 4), research and extension should be inserted into a broad participatory framework, adding to, rather than replacing the choices offered by multiple formal and informal sources.

(5) *Enabling agricultural intensification* (increased output or value per hectare through increased labour, knowledge or capital inputs). Many observers of African farming systems predicted Malthusian outcomes from population increase, while in India (where Ester Boserup (1965) formulated her counter-theory), dryland systems with higher population densities are playing out such transitions on a far longer time-scale. There are also contrasts within Africa, such as those in north-east Nigeria and semi-arid Kenya. The concept of a 'human carrying capacity' has been discredited in Africa, yet the question remains, how far can agricultural intensification go? Notwithstanding urbanisation, high or increasing population densities can be expected to persist in the Sahel, north-west and south-central India, southern Malawi and elsewhere. Many

Box 4. Pearl millet conservation in four villages

Farmers select, test and seek to extend a range of cultivated plants whose genetic characters can be matched with the diversity of micro-environments in which they work (soil chemical, physical and moisture conditions, rainfall, and pest or disease risk). Drylands are a specialised habitat for such genetic management, and contain more biodiversity than might be expected.

Farmers in Tumbau, Dagaceri, Kaska and Futchimiram villages use from 3 to 12 named types ('populations') of pearl millet. These have been assembled from local inheritances, their own selections from planted material, and imported types with recognised advantages over indigenous ones in today's adverse climatic conditions. In none of the villages were improved types acquired directly from extension agents, but several of those used could be traced back to types developed on agricultural stations, in Nigeria or in neighbouring Niger, from which they have degenerated to a greater or lesser extent through outcrossing.

A study of the genetic diversity of three named pearl millet populations (*badenji*, *dan arb'ain,* and *lafsir*), which are used in these villages, showed that diversity within each population is high - which is an advantage in a risky environment - and (unexpectedly) that *different* populations grown by the same farmer are genetically less diverse than the *same* populations grown in different villages. This suggests that each farmer, by seed selection and replanting from year to year, operates a miniature gene pool which he or she attempts to manipulate to obtain desired characters of resistance, processing or cooking.

Sources: Mortimore and Adams (1999); Busso *et al.*(forthcoming).

people retain strong links with rural areas after migrating (often temporarily) to cities. Net capital flows may either impoverish or recapitalise farming systems, depending on their direction; they are susceptible to policy inducements.

Here we emphasise *enabling* intensification rather than promoting particular technical packages. Development agencies cannot directly influence the labour management decisions taken by individual households. These depend on many factors, including the factor ratios between land, labour, capital and knowledge at the farm level at a given time; as noted above, crop-livestock integration (which offers a route to intensification for farmers who cannot afford inorganic fertilisers) is itself conditional. This explains why attempts to force the pace have sometimes been disappointing. Nor should they necessarily interfere with land or resource tenure, since experience shows that such interventions can obstruct flexibility, and redistribute benefits in inequitable or unforeseen ways. What they can do is to help extend the range of technologies available to farmers who are working with a land constraint, and promote markets.

(6) *Promoting markets.* The study showed that even 'remote' communities are integrated into national and regional markets for food, livestock and other products. Urbanisation, rather than global demand, is now driving many such markets. At the

same time, it must be recognised that more people, activities, commodities and factors of production are entering local markets and exchange systems, both in response to risk, and in the hope of accumulating wealth. Unregulated informal markets are more dynamic than regulated ones; open borders (at least in the Sahel) contribute to economic security. Policy priorities are, therefore, improving farmgate prices, transport and marketing infrastructures, and access to higher value product markets.

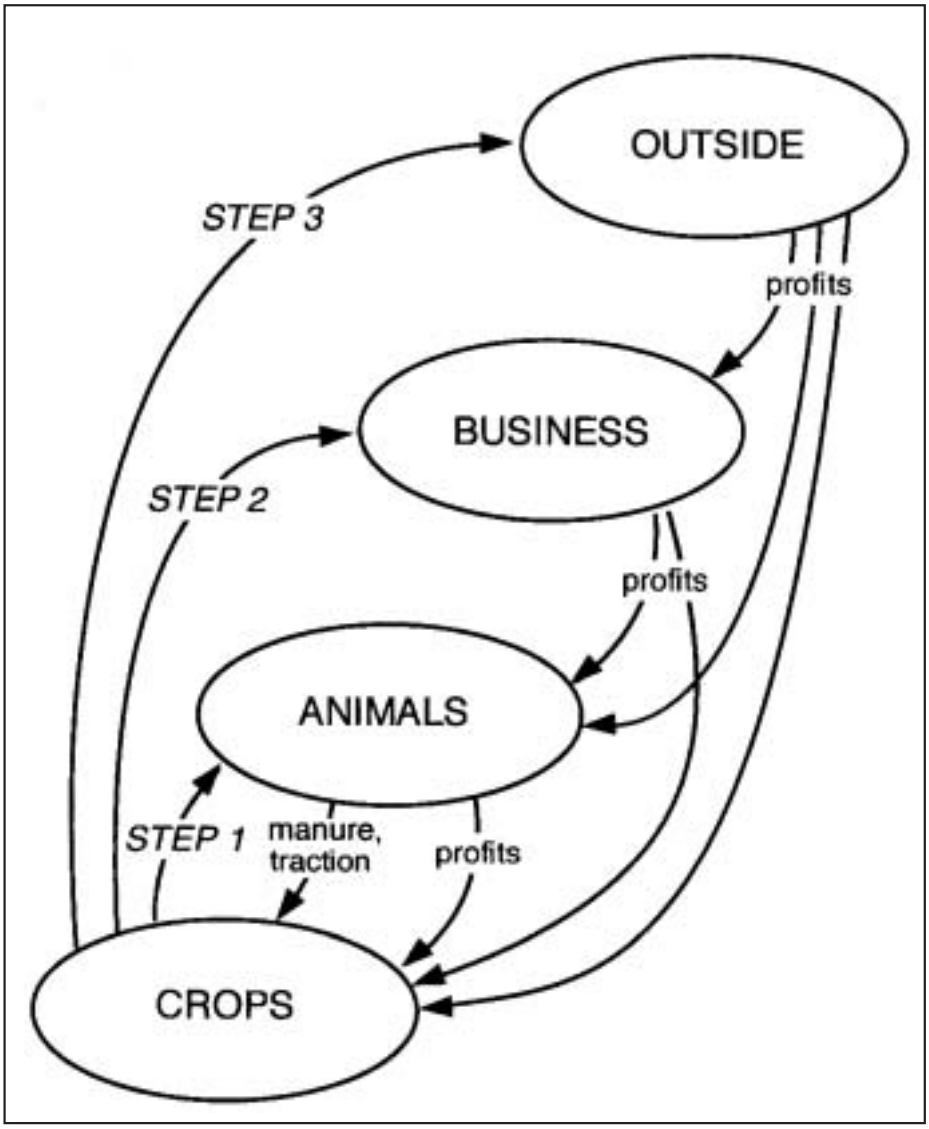
The exploitation of specialised market niches by Indian dryland farmers has something to teach their counterparts in Nigeria, where the production of export crops has now been replaced by diversification into food production for internal markets. Basic food markets appear to be more diverse and more efficient in India than in Africa. On the other hand, in southern Africa the tentacles of the South African mining industry reached to every village, affecting the opportunity costs of farm labour and thereby distorting many of the relationships suggested above for the more autonomous Nigerian systems. African smallholders still wrestle with the aftermath of colonial distortions which conceded them access to markets only reluctantly. Even in West Africa, globalisation during colonial times has been represented by some scholars as largely malign, and in Senegal (for example), dependence on exported groundnuts (together with many years of state-directed and capitalised production) seems to have weakened local markets.

(7) *Supporting multi-sectoral objectives.* Inclusion of households' non-farm labour commitments in agendas for rural and community development will benefit a wider social spectrum than addressing only questions of agricultural productivity. Also, off-farm activity is sometimes notably dynamic, as well as diverse. As allocations of labour and scarce capital resources must compete with other sectors of the household economy, understanding the livelihood system as a whole - not merely the natural resources - is a prerequisite of interventions or policies in the rural non-farm sector, especially in the Sahel where diversification represents a key resource for dealing with rainfall variability (Box 5).

(8) *Alleviating poverty among vulnerable households.* Small households are more stressed than larger ones, as they have less scope for flexible use of their labour and for pooling individuals' capital resources. Poverty programmes should take account of both the weakness of small households' resource endowments (labour in particular), and of their operational difficulties. Defining poor households as small households is an oversimplification. But demographics are linked with social differentiation in the community.

(9) *Alleviating poverty among women.* The large amounts of female labour time put into domestic work, and the competition that is implicit between farm and domestic work, underline the need to identify development objectives clearly. Development interventions intended to benefit women farmers require a basis in culturally acceptable and site-specific data.

Box 5. A model of diversification in the household economy



On-farm crop diversification responds to new market opportunities created by urbanisation and improved infrastructures. Then, the first step in diversifying out from the farm is into livestock ownership. Whether owning animals or not, scarcely an individual in the four villages (above the age of 12) lacks a source, however small, of income from trading, making articles for sale, or providing services; it is part of being a complete person. We call such activity 'business', the second step. Away from the farm and household, people pursue other activities, many of which provide income but may also have social, religious, or political connotations; the third step.

(10) *Reducing the impact of sickness.* Time lost to sickness was quantified in Nigeria (Mortimore and Adams, 1999), although without analysis of specific medical conditions. Given the critical role of labour in the production systems, the heavy use of available labour at certain times, and the arduous nature of farm work in high temperatures and humidity (which bears on all, irrespective of age or sex), non-work (both rest and sickness) has both economic and nutritional significance.

Drylands systems research in relation to alternative approaches

We have argued that the systems approach used to research the Nigerian drylands has relevance to the Indian and southern African drylands. How does it relate to other approaches in common use, and in particular, Farming Systems Research (FSR), Farmer Participatory Research (FPR), and the Sustainable Livelihoods (SL) approach?

Farming Systems Research (Okali *et al*., 1994; Martin and Sherington, 1997) was developed in the 1970s and 1980s in response to a need to: *"escape the single commodity focus [of station research] and concentrate specifically on farmers' actual circumstances, integrating farmers into the research process. An important development is that agriculture came to be seen as an holistic system in which all important interactions (ecological, biological, social, economic and political) should be considered"* (Dorward *et al*., 1997). However, in practice, FSR work was primarily concerned with the development of farm technologies.

With regard to Farmer Participatory Research, Okali *et al*. (1994) write: *"the current interest in farmer participatory research has developed at the confluence of several major development themes: farming systems research, participation, empowerment, the importance of local knowledge systems, the role of NGOs, etc. Farmer participatory research has rightly generated considerable excitement, as it has attempted to move beyond the formal interactions that characterised much farmer participation in the early years of farming systems research"*. However, whether FPR represents a conceptual or merely a methodological advance on FSR, it remains focused on farmers and on the development of farm technologies.

The Sustainable Livelihoods (SL) approach (Box 6), however, is founded on the fact that rural households are multi-sectoral and complex, agriculture being but a part (if, often, the major part) of the structure for earning real incomes. A livelihood is: *"the capabilities, assets (including both material and social resources), and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the resource base"* (Carney, 1998). In a further development designed to clarify the targeting of analysis and action, a set of Poverty Aim Markers has been proposed to distinguish between three types of intervention (Box 6).

Box 6. The Sustainable Livelihoods approach and Poverty Aim Markers

Five kinds of capital assets are recognised in the SL approach: natural resource stocks; social resources (networks, groups, etc.); human knowledge, skills, abilities and health; physical infrastructure and equipment; and financial resources (savings, credit, remittances, etc.). Subject to the 'vulnerability context' of particular groups, which can be analysed in detail, these assets are transformed by means of various structures and processes into livelihood outcomes (Carney, 1998). A strong link is therefore inevitable between weak asset endowments and poverty. The SL approach recognises the multi-sectoral diversity of rural peoples' livelihoods and the linkages between micro- and macro-scale processes.

Poverty Aim Markers are a threefold typology of actions designed to intervene in poor people's livelihoods (Cox, Farrington and Gilling, 1998). (1) An 'enabling action' focuses on policy and institutional issues which reduce poverty and lead to social, environmental or economic benefits for the poor, for example fiscal reform, or land tenure legislation. (2) An 'inclusive action' aims to improve poor people's access to services, infrastructure, etc. on the basis of public sector programmes such as education or extension services. (3) A 'focused action' targets a specific social group or issue through a specific agency, eg., urban slum improvements, or poor peoples' advocacy. It has been suggested that research on poverty elimination should identify one type of action as its central focus.

The impetus for the SL approach is social and economic: a need to insert poor people's real circumstances into technological development, which offers a way forward from the impasse created by low uptake of 'improved' technologies. However, a restricted view of natural resources as stocks awaiting transformation into livelihoods (or incomes) would be inadequate. Renewable natural resources are, in reality, managed ecosystems, and subject to both internal and external dynamics. Not only the social distribution of access to (or denial of) their benefits is relevant, but also the nature and efficiency of the technologies used and the sustainability of their management. The level of management may range from minimal (eg., in forest reserves or game parks) through intrusive (eg., bush fallowing systems) to transformational (eg., irrigated systems).

The drylands need systems research which focuses on these management regimes, on the technologies used, their impact on ecosystems over time, their productivity and sustainability. The special limitations of natural resources in the drylands which we identified earlier (aridity, leading to low productive potential, and variability) constrain smallholders' management opportunities and drive income diversification, amplifying for poor people the effects of restricted asset portfolios. Poverty is linked with NR management, both directly (where families enjoy access rights) and indirectly (where they depend for employment, incomes or consumables on others who have such rights). Neither the emphasis on agriculture which is implicit in FSR and FPR, nor a rigid view of natural resources as assets, are sufficiently flexible to provide a framework for analysing drylands systems. Upon the analysis of the intricate linkages between social

and economic processes and structures on the one hand, and natural resource dynamics on the other, depends the identification of entry points for interventions targeted to poor people's needs.

This is not a plea for complex or academic research methodologies as such. Much is already known and on record about dryland communities (if good use is made of the literature, too often ignored by development agents). It is not necessary to research the entire system before arriving at options for intervention. But to intervene on the basis of untested assumptions about poor people's requirements will produce the same impasse as before. Given the diversity, dynamic, and adaptability of livelihood systems, the 'drylands systems research' framework illustrated in this paper is proposed as a way forward. 'Action research', in which an investigation of the system linkages forms a part of a development initiative, suggests itself as an attractive possibility.

References

Bourn, D. and Wint, W. 1994. Livestock, land use and agricultural intensification in sub-Saharan Africa. *Pastoral Development Network paper 37a.* Overseas Development Institute, London.

Busso, CK., Devos, KM., Mortimore, M., Adams, WM., Ross, G. Ambrose, MJ., Aldrick, S. and Gale, MD. Forthcoming. Genetic diversity among landraces of pearl millet *(Pennisetum glaucum)* under farmer management.

Carney, D. (ed.) 1998. *Sustainable Rural Livelihoods: What contribution can we make?* Department of International Development (DFID), London.

Chiroma, AM.1996. The farming system of Futchimiram, in Yobe State. Nigeria. In: Working Paper No.4: *Soils, Cultivars and Livelihoods in Northeast Nigeria*. Departments of Geography, Cambridge University and Bayero University, Kano.

Cox, A., Farrington, J. and Gilling, J. 1998. Reaching the poor? Developing a poverty screen for agricultural research proposals. *ODI Working Paper 112*, Overseas Development Institute, London.

CRIDA. 1997. *Vision - 2020. CRIDA Perspective Plan.* Central Research Institute for Dryland Agriculture, Indian Council for Agricultural Research, Hyderabad.

DFID. 1997. White Paper on International Development. Department for International Development, London.

DFID/NRSP. 1999. *The Systems Approach in the Natural Resources Systems Programme.* Renewable Natural Resources Knowledge Strategy, Department for International Development, London.

Dorward, PT., Shepherd, DD. and Wolmer, WL. 1997. Developing farm management type methods for participatory needs assessment. *Agricultural Systems*, 55(2): 239-56.

Harris, FMA. 1999. Nutrient management strategies of smallholder farmers in a short-fallow farming system in north-east Nigeria. *The Geographical Journal*, 165: 275-85.

Harris, FMA. 1998. Farm-level assessment of the nutrient balance in northern Nigeria. Agriculture, *Ecosystems and Environment*, 71: 201-14.

Haswell, M., 1975. *The Nature of Poverty: A case history of the first quarter-century after World War II*. Longmans, London.

Ibrahim, AM. 1996. The farming system of Kaska, Yobe State, Nigeria. In: Working Paper No.3: *Soils, Cultivars and Livelihoods in Northeast Nigeria*. Departments of Geography, Cambridge University and Bayero University, Kano.

Mohammed, S., 1996 The farming system of Dagaceri, Jigawa State, Nigeria. *Soils, Cultivars and Livelihoods in North-east Nigeria Working Paper No. 2*, Departments of Geography, Cambridge University and Bayero University, Kano.

Martin, A. and Sherington, J. 1997. Participatory research methods - implementation, effectiveness and institutional context. *Agricultural Systems*, 55(2): 195-216.

Mortimore, M. 1998. *Roots in the African Dust: Sustaining the Sub-Saharan drylands*. Cambridge University Press.

Mortimore, M. 1989. *Adapting to Drought. Farmers, famines and desertification in West Africa*. Cambridge University Press.

Mortimore, M. and Adams, WM. 1999. *Working the Sahel: Environment and society in northern Nigeria*. Routledge, London.

Okali, C., Sumberg, J. and Farrington, J. 1994. *Farmer Participatory Research. Rhetoric and reality*. Intermediate Technology Publications, London.

Snrech, S., with Cour, JM. de Lattre, A. and Naidet, JD. 1994. *West Africa Long-term Perspective Study. Preparing for the future: a vision of West Africa in the year 2020*. Paris: Club du Sahel/OECD, Paris.

Stewart, JI. 1991. Principles and performance of response farming. In: Muchow, RC. and Bellamy, JA. (eds.) *Climatic Risk in Crop Production: Models and management from the semi-arid tropics and subtropics*. CAB International, Wallingford.

Tiffen, M., Mortimore, M. and Gichuki, F. 1994. *More people, Less erosion. Environmental recovery in Kenya*. John Wiley, Chichester.

Turner, B. 1997. Land cover change around four villages in north-east Nigeria: methodology and results. In: Working Paper No.5: *Soils, Cultivars and Livelihoods in North-east Nigeria.* Departments of Geography, Cambridge University and Bayero University, Kano.

Walker, TS. and Ryan, JG. 1990. *Village and Household Economies in India's Semi-arid Tropics.* Johns Hopkins Press, Baltimore.

Yusuf, MA. 1996. The farming system of Tumbau, Kano State, Nigeria. *Soils, Cultivars and Livelihoods in North-east Nigeria* Working Paper No. 1, Departments of Geography, Cambridge University and Bayero University, Kano.

Gatekeeper Series

1. Pesticide Hazards in the Third World: New Evidence from the Philippines. 1987. J.A. McCracken and G.R. Conway.

2. Cash Crops, Food Crops and Agricultural Sustainability. 1987. E.B. Barbier.

3. Trees as Savings and Security for the Rural Poor. 1992. Robert Chambers, Czech Conroy and Melissa Leach. (1st edition, 1988)

4-12 Out of Print

13. Crop-Livestock Interactions for Sustainable Agriculture. 1989. Wolfgang Bayer and Ann Waters-Bayer.

14. Perspectives in Soil Erosion in Africa: Whose Problem? 1989. M. Fones-Sondell.

15-16. Out of Print

17. Development Assistance and the Environment: Translating Intentions into Practice. 1989. Marianne Wenning.

18. Energy for Livelihoods: Putting People Back into Africa's Woodfuel Crisis. 1989. Robin Mearns and Gerald Leach.

19. Crop Variety Mixtures in Marginal Environments. 1990. Janice Jiggins.

20. Displaced Pastoralists and Transferred Wheat Technology in Tanzania. 1990. Charles Lane and Jules N. Pretty.

21. Teaching Threatens Sustainable Agriculture. 1990. Raymond I. Ison.

22. Microenvironments Unobserved. 1990. Robert Chambers.

23. Low Input Soil Restoration in Honduras: the Cantarranas Farmer-to-Farmer Extension Programme. 1990. Roland Bunch.

24. Rural Common Property Resources: A Growing Crisis. 1991. N.S. Jodha.

25. Participatory Education and Grassroots Development: The Case of Rural Appalachia. 1991. John Gaventa and Helen Lewis.

26. Farmer Organisations in Ecuador: Contributions to Farmer First Research and Development. 1991. A. Bebbington.

27. Indigenous Soil and Water Conservation in Africa. 1991. Reij. C.

28. Tree Products in Agroecosystems: Economic and Policy Issues. 1991. J.E.M. Arnold.

29. Designing Integrated Pest Management for Sustainable and Productive Futures. 1991. Michel P. Pimbert.

30. Plants, Genes and People: Improving the Relevance of Plant Breeding. 1991. Angelique Haugerud and Michael P. Collinson.

31. Local Institutions and Participation for Sustainable Development. 1992. Norman Uphoff.

32. The Information Drain: Obstacles to Research in Africa. 1992. Mamman Aminu Ibrahim.

33. Local Agro-Processing with Sustainable Technology: Sunflowerseed Oil in Tanzania. 1992. Eric Hyman.

34. Indigenous Soil and Water Conservation in India's Semi-Arid Tropics. 1992. John Kerr and N.K. Sanghi.

35. Prioritizing Institutional Development: A New Role for NGO Centres for Study and Development. 1992. Alan Fowler.

36. Out of Print

37. Livestock, Nutrient Cycling and Sustainable Agriculture in the West African Sahel. 1993. J.M. Powell and T.O. Williams.

38. O.K., The Data's Lousy, But It's All We've Got (Being a Critique of Conventional Methods. 1993. G. Gill.

39. Homegarden Systems: Agricultural Characteristics and Challenges. 1993. Inge D. Hoogerbrugge and Louise O. Fresco.

40. Opportunities for Expanding Water Harvesting in Sub-Saharan Africa: The Case of the Teras of Kassala. 1993. Johan A. Van Dijk and Mohamed Hassan Ahmed.

41 Out of Print

42. Community First: Landcare in Australia. 1994. Andrew Campbell.

43. From Research to Innovation: Getting the Most from Interaction with NGOs in Farming Systems Research and Extension. 1994. John Farrington and Anthony Bebbington.

44. Will Farmer Participatory Research Survive in the International Agricultural Research Centres? 1994. Sam Fujisaka.

45. Population Growth and Environmental Recovery: Policy Lessons from Kenya. 1994. Mary Tiffen, Michael Mortimore and Francis Gichuki.

46. Two Steps Back, One Step Forward: Cuba's National Policy for Alternative Agriculture. 1994. Peter Rosset and Medea Benjamin.

47. The Role of Mobility Within the Risk Management Strategies of Pastoralists and Agro-Pastoralists. 1994. Brent Swallow.

48. Participatory Agricultural Extension: Experiences from West Africa. 1995. Tom Osborn.

49. Women and Water Resources: Continued Marginalisation and New Policies. 1995. Francis Cleaver and Diane Elson.

50. New Horizons: The Economic, Social and Environmental Impacts of Participatory Watershed Development. 1995. Fiona Hinchcliffe, Irene Guijt, Jules N. Pretty and Parmesh Shah.

51. Participatory Selection of Beans in Rwanda: Results, Methods and Institutional Issues. 1995. Louise Sperling and Urs Scheidegger.

52. Trees and Trade-offs: A Stakeholder Approach to Natural Resource Management. 1995. Robin Grimble, Man-Kwun Chan, Julia Aglionby and Julian Quan.

53. A Role for Common Property Institutions in Land Redistribution Programmes in South Africa. 1995. Ben Cousins.

54. Linking Women to the Main Canal: Gender and Irrigation Management. 1995. Margreet Zwarteveen.

55. Soil Recuperation in Central America: Sustaining Innovation After Intervention. 1995. Roland Bunch and Gabinò López.

56. Through the Roadblocks: IPM and Central American Smallholders. 1996. Jeffery Bentley and Keith Andrews.

57. The Conditions for Collective Action: Land Tenure and Farmers' Groups in the Rajasthan Canal Project. 1996. Saurabh Sinha.

58. Networking for Sustainable Agriculture: Lessons from Animal Traction Development. 1996. Paul Starkey.

59. Intensification of Agriculture in Semi-Arid Areas: Lessons from the Kano Close-Settled Zone, Nigeria. 1996. Frances Harris.

60. Sustainable Agriculture: Impacts on Food Production and Food Security. 1996. Jules Pretty, John Thompson and Fiona Hinchcliffe.

61. Subsidies in Watershed Development Projects in India: Distortions and Opportunities. 1996. John M. Kerr, N.K. Sanghi and G. Sriramappa.

62. Multi-level Participatory Planning for Water Resources Development in Sri Lanka. 1996. K. Jinapala, Jeffrey D. Brewer, R. Sakthivadivel.

63. Hitting a Moving Target: Endogenous Development in Marginal European Areas. 1996. Gaston G.A. Remmers.

64. Poverty, Pluralism and Extension Practice. 1996. Ian Christoplos.

65. Conserving India's Agro-Biodiversity: Prospects and Policy Implications. 1997. Ashish Kothari.

66. Understanding Farmers' Communication Networks: Combining PRA With Agricultural Knowledge Systems Analysis. 1997. Ricardo Ramirez.

67. Markets and Modernisation: New Directions for Latin American Peasant Agriculture. 1997. Julio A. Berdegué and Germán Escobar.

68. Challenging 'Community' Definitions in Sustainable Natural Resource Management: The case of wild mushroom harvesting in the USA. 1997. Rebecca McLain and Eric Jones.

69. Process, Property and Patrons: Land Reform In Upland Thai Catchments. 1997. Roger Attwater.

70. Building Linkages for Livelihood Security in Chivi, Zimbabwe. 1997. Simon Croxton and Kudakwashe Murwira.

71. Propelling Change from the Bottom-Up: Institutional Reform in Zimbabwe. 1997. J. Hagmann, E. Chuma, M. Connolly and K. Murwira.

72. Gender is not a Sensitive Issue: Institutionalising a Gender-Oriented Participatory Approach in Siavonga, Zambia. 1997. Christiane Frischmuth.

73. A Hidden Threat to Food Production: Air Pollution and Agriculture in the Developing World. 1997. F. Marshall, Mike Ashmore and Fiona Hinchcliffe.

74. Policy Research and the Policy Process: Do the Twain ever Meet? 1998. James L. Garrett and Yassir Islam.

75. Lessons for the Large-Scale Application of Process Approaches from Sri Lanka. 1998. Richard Bond.

76. Malthus Revisited: People, Population and the Village Commons in Colombia. 1998. Juan Camilo Cardenas.

77. Bridging the Divide: Rural-Urban Interactions and Livelihood Strategies. 1998. Cecilia Tacoli.

78. Beyond the Farmer Field School: IPM and Empowerment in Indonesia. 1998. Peter A. C. Ooi.

79 The Rocky Road Towards Sustainable Livelihoods: Land Reform in Free State, South Africa. 1998. James Carnegie, Mathilda Roos, Mncedisi Madolo, Challa Moahloli and Joanne Abbot.

80 Community-based Conservation: Experiences from Zanzibar. 1998. Andrew Williams, Thabit S. Masoud and Wahira J. Othman.

81 Participatory Watershed Research and Management: Where the Shadow Falls. 1998. Robert E. Rhoades.

82 Thirty Cabbages: Greening the Agricultural 'Life Science' Industry. 1998 William T. Vorley.

83 Dimensions of Participation in Evaluation: Experiences from Zimbabwe and the Sudan. 1999. Joanne Harnmeijer, Ann Waters-Bayer and Wolfgang Bayer

84 Mad Cows and Bad Berries. 1999. David Waltner-Toews.

85. Sharing the Last Drop: Water Scarcity, Irrigation and Gendered Poverty Eradication. 1999. Barbara van Koppen.

86. IPM and the Citrus Industry in South Africa. 1999. Penny Urquhart

87. Making Water Management Everybody's Business: Water Harvesting and Rural Development in India. 1999. Anil Agarwal and Sunita Narain

88. Sustaining the Multiple Functions of Agricultural Biodiversity. 1999. Michel Pimbert

89. Demystifying Facilitation in Participatory Development. 2000. Annemarie Groot and Marleen Maarleveld

90. Woodlots, Woodfuel and Wildlife: Lessons from Queen Elizabeth National Park, Uganda. 2000. Tom Blomley

91. Borders, Rules and Governance: Mapping to catalyse changes in policy and management. 2000. Janis B. Alcorn

92. Women's Participation in Watershed Development in India. 2000. Janet Seeley, Meenakshi Batra and Madhu Sarin

93. A Study of Biopesticides and Biofertilisers in Haryana, India. 2000. Ghayur Alam

94. Poverty and Systems Research in the Drylands. 2000. Michael Mortimore, Bill Adams and Frances Harris

Gatekeeper papers

can be purchased from IIED's bookshop. Contact The Bookshop, 3 Endsleigh Street, London WC1H ODD, UK.
Telephone: +44 (0)20 7388 2117
Facsimile: +44 (0)20 7388 2826
E-mail: bookshop@iied.org
Internet: http://www.iied.org/

For further information about the series contact:

The Sustainable Agriculture and Rural Livelihoods Programme at the same address, or e-mail: sustag@iied.org

iied

International Institute for Environment and Development

Sustainable Agriculture and Rural Livelihoods Programme

Sida

The Sustainable Agriculture and Rural Livelihoods Programme

The Sustainable Agriculture and Rural Livelihoods Programme of IIED promotes and supports the development of socially and environmentally aware agriculture through policy research, training and capacity strengthening, networking and information dissemination, and advisory services.

The Programme emphasises close collaboration and consultation with a wide range of institutions in the South. Collaborative research projects are aimed at identifying the constraints and potentials of the livelihood strategies of the Third World poor who are affected by ecological, economic and social change. These initiatives focus on the development and application of participatory approaches to research and development; resource conserving technologies and practices; collective approaches to resource management; the value of wild foods and resources; rural-urban interactions; and policies and institutions that work for sustainable agriculture.

The Programme supports the exchange of field experiences through a range of formal and informal publications, including *PLA Notes* (*Notes on Participatory Learning and Action* – formerly *RRA Notes*), the *IIED Participatory Methodology Series*, the *Working Paper Series*, and the *Gatekeeper Series*. It receives funding from the Swedish International Development Cooperation Agency, the British Department for International Development, the Danish Ministry of Foreign Affairs, the Swiss Agency for Development and Cooperation, and other diverse sources.

International Institute for Environment and Development
3 Endsleigh Street
London
WC1H 0DD

Tel: **(+44 020) 7388 2117**
Fax: **(+44 020) 7388 2826**
E-mail: **sustag@iied.org**

ISSN 1357-9258