Participatory watershed management
Lessons from RELMA's experience in eastern and southern Africa

Azene Bekele-Tesemma and Gathiru Kimaru
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Lessons from RELMA’s work with farmers in eastern Africa

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Correct citation


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Tel: +254(0)20 7224000, via USA +1 650 833 6645
Fax: +254(0)20 7224001, via USA +1 650 833 6646
Email: icraf@cgiar.org
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About the authors

Azene Bekele-Tesemma, agroforestry specialist, Capacity Building Advisor, World Agroforestry Centre, P.O. Box 30677, Nairobi, Kenya. (azene.bekele@cgiar.org)

Gathiru Kimaru, land management and conservation specialist, P.O. Box 2239, Embu, Kenya. (gkimaru2006@yahoo.com)
Abstract

Participatory watershed management was one of the major interventions of the Regional Land Management Unit (RELMA) in eastern Africa. RELMA promoted methods and approaches that have made farmers trust extension workers. Its programmes across the region popularised farmer-driven and expert-guided socio-economic diagnosis and environmental assessment, planning, implementation and monitoring procedures at the watershed and household levels. In the process, RELMA has gathered extensive experience on how to simplify know-how and procedures in watershed management so that farmers can easily understand them. This experience includes development of systems and tools that make it easier to transfer knowledge and skills in watershed management between countries by harmonising procedures across agroclimatic zones. This paper documents these experiences. It captures methods used to build trust among farmers and extension providers. It discussed the use of community role models and customized PRA techniques, technology demonstrations, and field reconnaissance, all effective approaches to encourage the participation of farmers in projects. Farming system analysis, deployment of multidisciplinary teams and use of information and an incentive have been studied as major socioeconomic assessment variables. The nature of indigenous knowledge, including its associated weaknesses and adaptive mechanisms, has also been considered. Criteria used by farmers in environmental diagnosis and to assess land potential assessment are studied. Likewise, factors that dictate farmers’ decisions in selecting the type of production on a given parcel of land in a watershed setting are studied along with socioeconomic conditions and market principles. Finally, the paper assesses the criteria that farmers use to monitor and evaluate the contribution of indigenous knowledge and innovations in watershed management. In conclusion, the paper gives recommendations based on this experiences and professional reflections.

Key words: Watershed management, RELMA, soft system, farmer-participatory, indigenous knowledge.
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### Acronyms

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<th>Description</th>
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<tr>
<td>NSWCP</td>
<td>National soil and water conservation programme</td>
</tr>
<tr>
<td>SCAPA</td>
<td>Soil conservation and agroforestry programme in Arusha</td>
</tr>
<tr>
<td>ULAMP</td>
<td>Uganda land management programme</td>
</tr>
<tr>
<td>EHRS</td>
<td>Ethiopian highland reclamation studies</td>
</tr>
<tr>
<td>PRA</td>
<td>participatory rural appraisal</td>
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</tbody>
</table>
Introduction

Purpose and scope
The rural economies of the eastern Africa provide livelihoods for 60-80% of the population engaged in agriculture or related non-farm activities. However, agriculture has been performing poorly in the past few decades. Declining productivity has contributed to worsening poverty and food insecurity that affects more than half of the region’s population.

There are many reasons for falling productivity. Firstly, the region’s economies are not market oriented. As a result, there is inadequate access to agricultural credit, farm inputs are costly, and the growth of services that add value to produce is slow. In addition, communication, energy and market infrastructures are poor. In most cases, farmers are unable to meet the quantity, quality and continuity requirements of the markets.

Furthermore, research-extension linkages are weak and there is lack of technical innovation in agriculture and poor knowledge of modern methods or their optimal application. While liberalization policies have pushed for cuts in the public extension services, the private sector, which is expected to fill the gap, has failed to live up to be an effective replacement. In many areas, poor governance has led to a near-collapse of the cooperatives sector. All these factors have created a growing vacuum that has led to declining production, reduced investment in land care and increased land degradation.

The Swedish International Development Agency (Sida), through the Regional Land Management Unit (RELMA), has supported long-running land management programmes that have generated a wealth of experiences. Now that RELMA has merged with the World Agroforestry Centre (ICRAF), these experiences should be useful in designing approaches to effectively reach out to millions of small-scale land users in Sub-Saharan Africa. This study summarises RELMA’s experience in market-focused watershed management and recommends how the approach can be used to improve future programmes.
Effective participatory diagnostic approaches and tools

Building trust in frontline extension workers

RELMA promotes its programmes mainly through extension workers at the grassroots. These frontline workers interact with farmers and understand local circumstances. Extension service providers are key to RELMA’s work with farmers. They are best placed to identify various socio-economic diagnostic tools suitable for given communities and can guide community-driven planning for specific watersheds.

Extension workers are most successful when they are available to work with the farmers, follow up activities and draw sub-plans, such as those for seasonal activities, and discuss everyday problems. It is important for extension agents to be credible – for instance, by delivering what they promise. It helps if they speak the local language, preferably speakers, to take advantage of the rich reserve of local legends, fables, myths and humour in communicating different messages.

Successful extension workers show respect for the farmers, keep appointments, and know the farmers’ limits of privacy. By participating in other non-technical social activities such as weddings, burials and sports, the extension workers can gain the confidence of the community. For this reason, RELMA has used the local extension workers as the immediate targets (main link) with the farmers’ groups, the ultimate targets of the various programmes. Indeed trust building by extension workers is a primary step in RELMA’s six-step development extension approaches (Bekele-Tesemma and I. Bekalo, 2005).

In many areas, farmers work together in groups, helping one another during weddings, funerals and other social occasions. This tradition of communal action has been applied to soil and water conservation work, tree planting and land preparation.

It its group-based approach, RELMA uses local traditions and customs to reach out to farmers. For instance, RELMA has used new or existing common interest groups (CIGs) to promote integrated household food production and water harvesting. The groups have also been used to rehabilitate degraded areas and improve soil fertility.

Use of community role players

Communities rely a lot on informal leaders who command respect and integrity. Such leaders are often hardworking elders who are progressive and social. As role models, they are known for their success in life and like to share ideas with neighbours. They
have information on a wide range of subjects. For instance, they are knowledgeable about land management and agriculture in areas outside their own communities.

People in their communities visit them to learn new ways of farming, get new or improved seed varieties. Such local leaders are usually elected to head the common interest groups that RELMA promotes. They play an important in communicating to the communities about improved land management. They also help to ensure sustainability after external players pull out.

In some cases, the role players may not hold formal or elected leadership positions, but command tremendous respect because of one or a combination of the following:

- Perceived superior knowledge and exposure acquired through education, training or wide travel.
- Skills acquired through work and practice.
- Having a ‘people-orientation’ without necessarily being in formal leadership, for example, through involvement in community work to solve common problems.
- Coming from respected families associated with order, integrity and success.

Use of customized PRA techniques

Use of PRA (participatory rural appraisal) has been popularized in many countries as a way to reverse the traditional ‘top-down’ approach in research and development. Often, however, PRA is used to extract information from farmers without the empowerment that is implied in effective participation. Over the past two decades, farmers have been put through the same questioning routines that inadvertently ‘train’ them to give standard responses to enquiries by those they consider outsiders.

RELMA was able to get farmers’ confidence by encouraging their participation in activities that affect them. The case of an integrated household food production
project in Machakos District, Kenya, illustrates the participatory approach common to RELMA projects elsewhere. In the project, water was identified as an entry point around which farmers’ groups freely expressed their aspirations and constraints. These were then shaped into opportunities based on the resources available and the situation of each farm, taking into consideration size, soils, agroclimatic zone, distance to markets and physical infrastructure.

RELMA staff spent many days working with farmers in the villages. Such interaction is important to gain the people’s confidence. PRA techniques were suitably used during such interaction. Sometimes joining community members to help in regular tasks such as weeding, harvesting or thrashing their crop was found to be an effective way to stimulate discussions and obtain information from informants in the community. This approach, which does not use pen and paper to record observations, is especially useful in situations where a group is involved or where there are gender, wealth and traditional disparities among parties.

**Learning tours for farmers and extension workers**

Modernizing agriculture requires that farmers have easy access to information such as that on new production technologies, how to add value to their produce or where to find markets.

RELMA used field tours to help farmers learn by seeing what others were doing. Such tours were an important of way sharing information between different areas in the same country and across countries. For instance, farmers, primary school teachers and extension workers from Tanzania, Uganda, Kenya and Zambia visited market-focused watershed management areas in Ethiopia. They learnt how to mainstream market-focused watershed management in primary school syllabi and field extension packages. On the other hand, farmers, extension workers and district administrators from Ethiopia toured Kenya and Uganda to learn from decentralized governance and land management experiences in these countries.

**Technology demonstrations**

Often many standard solutions to problems cannot be replicated over large areas. An important challenge in watershed management is to develop technology with the people in their localities, rather than transferring that developed elsewhere under different conditions. One of the best ways to develop locally appropriate technologies is by involving farmers in on-farm trials and demonstrations, preferably with the farmers sharing the costs.
In collaboration with the University of Nairobi, RELMA conducted soil fertility studies and demonstrations in Kirinyaga District, Kenya, with full involvement of local extension service providers and the farmers. Similar activities were carried out in Tanzanian, specifically in the central region of Morogoro and Iringa in the southern highlands. The experience showed that approaches that avoid the conventional prescriptive view but instead focus on relevance to community priorities and circumstances work well.

**Understanding the socio-economic environment at sites**

**Multidisciplinary perspective**

Observation of conserved areas and the number of farms improved over time gives an indication of the farmers’ response to approaches and technologies – and incentives. The RELMA experience shows that if watershed programmes focus only on soil and water conservation, they eventually become irrelevant and fail to cover the areas targeted or meet the objectives for which they were set up.

Soon after the beginning of soil and water conservation programmes, the need arises for turning technology development towards providing wider land-use options. These alternatives should include markets as a major force behind soil and water conservation, improved land management and better agricultural production. In line with this thinking, RELMA aims to improve production, which, in turn, encourages conservation as a spin-off.

**Farming systems**

The willingness of farmers to invest in land improvement, the number and proportion of participating farmers in a watershed – and therefore the success of land management programmes – depends on the different conditions within the watershed. Farmers who are most dependent on crop production for their livelihoods appear to be more willing to invest in better land management and conservation. This is usually the case in densely populated areas with a concentration of smallholdings and where land is highly valuable.

In recent years, economic liberalization has stimulated investment in improved land management by opening up markets and raising producer prices. However, the value addition sector – especially the bulking, quality grading, standardizing, branding and continuity of supply – has not equally improved to meet market requirements and
dislodge farmers’ children from over-burdened land. This may affect the sustainability of investment in land management.

Nomadic pastoral peoples use vast areas in the drier zones, often moving with the seasons and availability of water and pasture. These areas are relatively sparsely populated. As a result, they tend not to attract official investments in infrastructure development, extension and research.

Although economic liberalization has encouraged a commercial orientation in livestock production in these areas, there are big challenges. Poor roads, lack of water, inadequate disease control and inadequate social amenities for remain a big hindrance to livestock development because they make business costly.

It should be noted that in these drier areas, communal management and control systems are still a major ingredient in improved management of land and other resources on a watershed scale.

**Property rights and conservation**

Property rights – ownership, use and access, inheritance – often influence decisions on investment in land management and conservation. Such rights may be customary or legally entrenched, communal, private/individual, seasonal or permanent. The rights may also be linked to use of specific resources such as firewood and building materials, water or grazing. In Tikurso watershed, Ethiopia, land tenure is known to affect farmers’ decisions to accept and implement soil and water conservation measures such as constructing long-lasting terraces or planting trees on their farms by 13% each.

Recognising the link between land rights and conservation, RELMA has been promoting land tenure policies that encourage farmers to improve land management. However, since land tenure evolves over time, RELMA’s approach focuses on the ‘land user’ rather than ‘land owner’.

In some areas, cropped areas remain ‘private’ only as long as the crop is on the farm. After harvesting, the areas revert to open access or common property that can be used as communal grazing land. This makes it difficult to maintain conservation measures, particularly physical and vegetative ones.

To help overcome this problem, RELMA promoted appropriate levels of crop livestock integration into land improvement. For instance, farmers were encouraged to conserve and store fodder during the rainy seasons and to collect stover outside cultivated areas to feed livestock. Programmes also promoted zero-grazing or stall-
feeding systems that encouraged fodder production and recycling of manure to enhance soil fertility.

In addition, RELMA’s experience has shown that integrating trees around the farm (along boundaries and contours) with the conservation structures could demonstrate to the community that the land is no longer idle. This would discourage people from taking their animals to graze in the conserved areas after crops have been harvested.

**Provision of information as an incentive**

Effective flow of information is a critical incentive for extension workers and farmers in successful land management and conservation programmes. RELMA aimed to create an appropriate infrastructure for information flow, technology promotion, value addition and marketing.

Much information has been collected and packaged into a variety of publications that have been widely disseminated to extension workers and farmers in the region. A few of these publications were packaged using a participatory ‘writeshop’ process involving farmers, development agents and extension workers as well as top experts in information packaging. A typical example is the publication *Managing land: A practical guidebook for development agents in Ethiopia* (2005).

The publications contain information that ranges from technological choices about land preparation, soil fertility maintenance, farm implements, to agro-forestry solutions, farmer organization and empowerment, local technological innovations and markets. The information is selected to ensure it is relevant and gives farmers a wide knowledge base to help them pick investment options.

**Role of indigenous knowledge on watershed management**

Land management interventions by research and extension systems have to properly interface with local or traditional knowledge and practices. For instance, on sloppy land, the management of water and runoff over many small farms is done through intricate negotiations to get farmers to cooperate in constructing drainage and conservation works.

However, some ‘modern’ approaches do not recognize the potential of using local knowledge in conservation and management of water resources including springs, riverbanks, marshes and swamps. Instead new agricultural programmes in the drier regions often target swamps and marshes for irrigation, leading to loss of dry season grazing, biodiversity and other watershed functions.
RELMA promoted the use of decentralized community institutions and local voluntary organizations to build on local traditions recognized the systems of self-governance at that level as a basis for developing improved and sustainable land management approaches and technologies. Traditional institutions such as the Mwethya groups of Machakos, Kenya, have been used to organize farmers to undertake considerable seasonal conservation work.

These voluntary organizations also constitute a nucleus for the improvement of production, commercial orientation of agriculture, enterprise diversification, high-value production and marketing. Adding value to local resources should be promoted using indigenous innovations as well as new external approaches and technologies. A good example is RELMA’s work with innovative farmer groups – such as the ones established at Armany and Dejen in Ethiopia – that use indigenous technologies adapted to modern land management at watershed level.

The use of soft-system approaches suited to local conditions is another strong point of RELMA’s land management interventions. Often some sites in watersheds have inherent constraints to addressing the production wishes of the land users. For instance, even on land with a slope greater than 45%, farmers may need to grow annual crops that require intensive land preparation by ploughing. Yet such land use on slopes could aggravate soil erosion and deplete the soil rapidly.

In such areas, RELMA advised extension workers to go for negotiated solutions that protect the land and help fulfil the land user’s desires. One solution recommended for such areas is plugging longitudinal strips planted with perennial commercial shrubs, which are inter-spaced with annual crop strips. Table 1 shows some of the common problems and recommended solutions (Azene Bekele-Tesemma 1997).

Table 1 Development issues of farmers’, associated problems and mediated solutions

<table>
<thead>
<tr>
<th>Production desires</th>
<th>Associated problems</th>
<th>Problem mitigation possibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximizing agricultural land</td>
<td>Slope limitation</td>
<td>Application of indigenous knowledge-based slope mitigating technologies.</td>
</tr>
<tr>
<td></td>
<td>Soil depth limitation</td>
<td>Making slope extremes slightly relaxed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Making soil depth boundaries slightly relaxed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Applying effective soil conservation measures</td>
</tr>
<tr>
<td>Maximizing short-term income</td>
<td>Long gestation period of perennial plants</td>
<td>Introducing cash-value shrubs which could be harvested in short rotations</td>
</tr>
<tr>
<td></td>
<td>Feed shortage for livestock keeping</td>
<td>Enhancing feed development such as grass covered bunds and fodder shrub lines</td>
</tr>
<tr>
<td></td>
<td>Lack of initial capital</td>
<td>Various kinds of incentives that contribute to availability of initial capital (see Recommendations in this paper)</td>
</tr>
</tbody>
</table>
Footpaths, stock and other accesses routes to water points are also established by traditional agreements. These passages often lead to erosion and gullies, but the conservation approach has to be implemented with the agreement of communities.

On the other hand, the construction of major highways and access roads across rural landscapes often disrupts traditional drainage arrangements because communities are not involved in planning or implementation and traditional practices are ignored. The result is deep gullies and damage to farmland.

A Sida-supported pilot project in Kenya’s Nyeri District in the 1980s showed that this can be avoided. The project brought together farmers, extension workers and engineers to plan together to avoid improper road drainage and ensure that productive land was not taken away or damaged. There was close collaboration between agricultural extension workers and engineers in designing the road, and the local community was involved in key decisions affecting their land. Such initiatives deserve to be highlighted and scaled up.

Where land is owned or controlled by the community, rather than individuals, the use of grazing resources is based on indigenous knowledge about seasons, vegetation growth cycles and the environment in general. Resources are shared equitably and traditional leaders resolve disputes that may arise. When these traditions are not followed, the results are social conflicts and accelerated land degradation. This has been the case in some parts of eastern Africa where there are serious land-use conflicts between pastoral peoples and the crop farmers. The main cause of tension is increased population pressure in the face of a breakdown of traditional governance and indigenous conflict resolution systems.
Adapting mechanisms and techniques

Indigenous knowledge may have its limits due to the greatly changed circumstances. These population increases and the consequent pressure on land, which is being subdivided into ever-smaller pieces. Other changes include migration of people into new environments, altered social conditions or the emergence of new problems. There is also the issue of fractional loss or ‘leakage’ of land-related knowledge in the oral process of inter-generational transmission, making it increasingly ineffective.

However, subjecting available traditional knowledge to peer review and critique, and developing customized and appropriate approaches make new technologies effective and acceptable. This further encourages farmers to play an active role in soil and water conservation programmes, invest more in land improvement, and venture into new areas of production and marketing.

In designing land management activities, researchers and extension workers should use local knowledge about soils, biodiversity, and soil and water conservation structures. Farmer-participatory research has been found effective in solving problems. For example, the solution to the problems of stone terracing – collapsing of terraces on steep slopes, rat harbouring, continuous need for height increment and taking land out of production – were effectively solved by the joint research findings of farmers and a researcher (Bekele-Tesemma 2001).

New land management plans should fit into traditional land rights and access arrangements, as illustrated by a RELMA-supported land rehabilitation project in Arusha, Tanzania. It was noted that farmers’ reluctance to support proposed land rehabilitation interventions was overcome only when their broad plan of land allocation to family members was incorporated into the conservation plan. This meant modifying the measurements of selected horizontal intervals (and hence the location of the respective contour lines) to become the boundaries between the individual plots for the family members. The modifications did not significantly affect the overall efficiency of the drainage and conservation system, but created considerable goodwill between the technical people and the farmers.

RELMA has observed that there is much experimentation by the local communities trying to deal with land conservation and rehabilitation problems. The focus is on soil conservation, improving soil moisture and maintaining its fertility to increase food crop yields and fodder production. For instance, farmers in Ethiopia trap the soil in floods using traditional tools and methods for improving soil depth (Bekele-Tesemma 1997). Technical personnel often ignore such efforts.

Similarly, there are numerous cases of farmers modifying gullies, using a combination of structural and vegetative measures, and using them in a variety of ways instead of...
simply plugging them through conventional treatments (Kithinji Mutunga and Will Critchley, 2001). The gullies are ‘healed’ and converted into productive land, for instance, by planting of fruit trees and grasses that help slow down or stop erosion. In other cases, the gullies are turned into ponds to harvest for irrigation.

Similarly, farmers have adapted recommended conservation structures to serve a wider variety of functions other than those originally intended by changing the design to fit new needs. For example, the original designs of the ‘fanya juu’ terrace, retention ditches and diversion structures have been modified to form effective water harvesting systems that have so far not been assigned precise technical guidelines by researchers or extension workers. Examples such as these illustrate the importance of obtaining sufficient information about initiatives that land users in a given watershed have undertaken without outside intervention.

**Farmers’ criteria for land potential assessment and prescription of land management options**

**Socio-economic levels**

Given a chance, farmers know how to classify community members into meaningful and acceptable socio-economic groups. For instance, in several meetings in Embu District, Kenya, in May and June 2005, farmers categorized themselves into three groups based on size of land and availability of water for irrigation (see appendix 1). Where water for irrigation is available, even very small farms (less than one hectare) can be used for intensive horticultural production for cash, and the owners are therefore regarded as ‘better-off’ or ‘rich’.

Farmers have to make crucial decisions on how to choose and combine different crops on the limited farmland over the seasons. These decisions are based on a number of factors including socio-economic situation, land tenure, farm size and availability of improved inputs such as good seed, fertilizers and water for irrigation. Other factors are markets and pricing of produce, agro-climatic zone and land quality (soil depth, soil fertility, slope, and drainage status). Some of these factors are often hidden from an external researcher or extension worker yet many a time such knowledge dictates success in watershed management.

The type of land tenure (ownership and access) is another socio-economic factor that may encourage or discourage land users from long-term plans and investments. At the watershed level, poor tenure creates problems that hamper coordinated action to develop land management and control systems.
Another socio-economic factor that negatively affects sustained success in land management is the fact that rural communities are not exposed to value-added production. For instance, the collapse of the raw coffee and cotton markets has forced farmers to abandon land conservation in areas where these crops were grown. Instead they have introduced other crops that require new land management approaches and technologies that most farmers do not know well. In addition, the new crops require frequent ploughing, leading to accelerated land degradation.

**Soils: depth, soil colour, rock outcrop**

Effective participatory socio-economic diagnosis involving farmers provides the necessary tools for farmers to assess land potential and constraints at watershed scale. Farmers have their own ways of judging land quality through observation. Soils vary widely over short distances (even between catenas in an individual farm plot). In discussions with farmers’ groups in Kirinyaga, on the slopes of Mt. Kenya, the farmers said they looked for certain soil characteristics including colour, depth, stoniness as well as signs of erosion on slopes in deciding on the potential of the land for various types of agricultural use.

Farmers also use such factors to value land for sale or to fairly apportion land among individuals. Dark-brown soil colours indicated high fertility and adequate use of manure (high soil organic matter), compared to red or light-coloured soils.

Soils with a loamy texture are also assumed to be more fertile than sandy soils. Farmers in different countries and traditions have their own vernacular terms for each of these soil colours and associated land qualities. Farmers associate different types of production to land potential as indicated by soil colours and textures. On fertile soils, they will plant the most important food crops or valuable seasonal cash crops, such as horticultural crops.

Farmers are familiar with the soil depths of their land. They judge soil depth by colour or nature of plants growing on the site. If soils are shallow, the crops and weeds will wither quickly after a short dry spell. In such areas the farmers would plant permanent pastures or certain trees, or crops that are said to be suited for poor soils such as sweet potatoes, cassava, and grass for pasture. On steep slopes with good soils, farmers have planted coffee or tea in areas unsuitable for annual cropping. On badly eroded land, they have trees, or napier grass (in pits or along strips).

The land potential is mirrored in the plants growing in specific areas. Farmers determine the potential of the land by observing the vigour and colour of growing crops and weeds. Healthy, vigorous, dark green crops grow on good soil. Crops on such soils also give good yields and are better able to withstand drought due to better
moisture storage in the soil. Weeds also grow well. For example, the weeds *Commelina* sp and *Galinsoga* sp point to medium or high soil fertility. In contrast, others such as *Striga* thrive in infertile soils. Certain hardy grasses also thrive in poor infertile soils with low organic matter.

Visual observation allows farmers to make decisions on land use, soil conservation and soil fertility. Such decisions include seeking extension advice. Visual observation, however, has limitations. It does not identify the nutrients in the soil, their quantities or proportions. Also, it does not give an accurate assessment of the physical, chemical and biological properties of soils. Such observation is, therefore, inadequate for designing specific solutions to poor crop performance (Gachene and Kimaru, 2003).

Farmers’ assessment of soil fertility, Kirinyaga, Central Kenya

<table>
<thead>
<tr>
<th>Indicators of good, fertile soil</th>
<th>Indicators of infertile soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good yields</td>
<td>Low yields</td>
</tr>
<tr>
<td>Healthy, vigorous, green crops</td>
<td>Stunted, poor and weak crops</td>
</tr>
<tr>
<td>Nature of soil: colour, depth</td>
<td>Yellow colour of crops and weeds</td>
</tr>
<tr>
<td>Presence of certain trees and shrubs</td>
<td>Certain weeds, especially hardy grasses</td>
</tr>
<tr>
<td>Heavy pest infestation</td>
<td>Nature of soil, colour, stoniness</td>
</tr>
<tr>
<td>Crops withstand drought</td>
<td>Presence of certain trees and shrubs</td>
</tr>
<tr>
<td>Weeds grow well</td>
<td>Erosion signs</td>
</tr>
<tr>
<td>Certain weeds (e.g. <em>Commelina</em> sp, <em>Galinsoga</em> sp.)</td>
<td>Crop and weed failure</td>
</tr>
<tr>
<td>Crops withstand short dry spells</td>
<td>Crops wither quickly after short dry spells</td>
</tr>
</tbody>
</table>

(Gachene and Kimaru, 2003).

In this study, farmers’ also listed 36 possible causes of soil fertility decline. Cassava, grass, napier grass, sweet potatoes as well as loquat and other trees were some of the crops mentioned as being grown on infertile soils by farmers in Kirinyaga.

**Agro-climatic zones**

RELMA has tried to harmonise the understanding about agroclimatic zones across countries in East Africa. Such synchronisation is crucial for the generation and transfer of knowledge in similar agroclimatic zones in the different countries. The zones range from wet and dry hot-lowland zones at lower altitudes to wet and dry alpine-frost zones higher up. Eighteen agroclimatic zones have been identified in the region, but RELMA has only provided land management options for the 13 most-inhabited of these zones (RELMA 2005).

The hot-lowlands are generally less than 500 metres in altitude. These may be dry, as in the Ogaden plains of Ethiopia or the Rift valley province of Kenya. The same hot-lowlands may be moist as in Gambella region of Ethiopia and adjoining lands of south Sudan. They may be wet, as in the islands of Zanzibar in Tanzania. In general, the
major economic activity is livestock rearing, which is only limited by availability of grazing land. The climate allows only the rearing of beef cattle, camels and goats, mainly for meat.

Government-run irrigation schemes for cotton, sugarcane and flower production have been developed in some of the areas where water is available from rivers. Except in wet hot-lowlands, situated on the Zanzibar islands, wind erosion and much higher evapotranspiration than precipitation are among the major land management constraints in the hot-lowlands.

The lowlands of 500 – 1500 m in altitude have mixed agriculture, with livestock still playing a key role in the household economy. Otherwise the choice of enterprises is strongly influenced by availability of rain, type of soils, technology options and market forces. There has been much human migration into these areas due to population pressure in the highlands. Much investment in dryland farming research in Kenya has been directed to these areas to develop suitable annual crop varieties and influenced the choice of crops to grow. Such crops include maize, millets, sorghum, pigeon peas, cotton and various bean varieties.

Market-oriented horticultural production is a major economic activity in the dry areas of Sub-Saharan Africa, but there is a need to invest in research in water efficient irrigation systems. Soil and water conservation in these areas is important to protect fragile soils and to improve moisture availability. Much focused research is also required to develop production systems that are water efficient.

Areas within the 1500 – 2300m range are known as mid-altitude highlands which are categorized into dry, moist and wet rainfall regimes. They are the most inhabited lands both by livestock and people. The lands have been subjected to repeated cultivation and vegetation manipulation. The major land management problems of watersheds in these areas are connected to rainfall and slope conditions.

The mid-altitude highlands are major agricultural production areas for food and cash crops, including coffee and various fruit tree species. These areas have also received much attention in research and development. As a result, the adoption of new technologies has led to improved market-oriented agricultural production.

In some areas, land has been sub-divided into small parcels that limit production and are generally degraded due to over-cultivation and lack of replenishment of soil nutrients. Watersheds in the high-rainfall (wet zones), mid-altitude highlands require special attention to control water erosion and protect the soils.

The other agroclimatic zones fall in the highlands of 2300 – 3200m above sea level. Although there are dry areas that receive less than 900 mm of rainfall in the Ethiopian
highlands, they usually fall in moist and wet rainfall regimes. Human and livestock populations in these areas are very high. The major crops are mainly legumes such as beans and peas. Quality timber trees including conifers grow very well here. The major watershed management problems are connected with high rainfall that is related to reduced evapotranspiration.

Frost zones occur at between 3200 and 3700m above sea level, while alpine frost zones are situated at altitudes greater than 3700m. Although the severity of frost and diversity of vegetation reduces as we move from frost zone to alpine frost zone, both are grazing lands habitats for wildlife. Frost and the low temperatures limit crop production.

Suitable crops include barley, pyrethrum, and Irish potatoes. Tea and temperate crops do well in these zones. Sheep also thrive while many farmers keep exotic high-yielding dairy cattle breeds.

The tea crop forms a dense canopy that protects the soil from erosion. Otherwise soil erosion is not a major problem due to good all-year-round ground cover.

**GIS analogy as used in farmer-participatory planning**

A broad range of variables that define land quality are known in farming communities. These are categories mainly relating slope, soil depth, and soil fertility. RELMA was interested in how farmers could realize the combined effect of these variables so that they could categorize their land units that require different land care measures. RELMA has through its farmer-participatory research and development efforts resolved this problem by implementing an approach that used a Global Information System (GIS) analogy to help farmers in specific catchments.

In this approach, farmers are encouraged to draw the farm boundaries on a transparent paper. Other features that are shared with other farm owners include streams, gullies and footpaths that influence land care on specific farms. These are all indicated on the map. The east-west direction is drawn using the shadow of trees and the farmer himself. The map is duplicated five times to show different factors. The five maps that follow show soil depth, slope, soil fertility class, soil-depth-cum-slope class composite, soil fertility-cum-soil depth-slope composite, and land potential class.

Extension workers then use one of the base maps to show the farmers how they can measure soil depth at less than 20 cm, 20 – 50 cm and greater than 50 cm. These measures are compared with those that farmers easily understand. Because the
farmers know their farm in detail, they can easily classify it into these three soil depth categories. The soil depth map is now developed.

Similarly, the second map is used to help farmers to classify the land they use into different slope categories. First, a demonstration is given on how to use clinometers to measure slopes of 2–5 %, 5–15 %, 15–30 %, 30–45 % and more than 45 %.

After the farmers understand about these slope magnitudes on their land -- usually after which normally takes 2 – 3 hours -- they are encouraged to categorize their farm into these slope categories. The slope map is now developed. The process is used to develop a soil fertility map on which farmers classify soils are poor, medium and somewhat good.

Next, farmers overlap the soil depth map onto the slope class map and delineate land units of different soil depth and slope combinations. This is similar to GIS except that farmers and extension workers do it using transparent papers. They note the specific combinations as they occur on the land and note quality differences and crucial land management issues. A composite map is developed with land management instructions that mitigate the major constraints in each of the specific land units.

In the next step, the soil fertility class map is then placed on the composite map prepared from the slope and soil depth situations. From these combinations, a land potential and constraint map is generated.

Such maps, drawn with active participation of the land users, are key tools for getting farmers to appreciate their land problems and potentials. The process is drawing the maps also motivates the farmers because they gain confidence that they can use their land wisely. This process has been tested in Tikurso watershed in Ethiopia and proved effective (Azene Bekele-Tesemma, 1997).

Factors dictating farmers’ decisions

What others are growing (the neighbourhood effect)

RELMA has learnt that many farmers follow tradition, planting ‘what has always been grown in this area’ and passing knowledge down from generation to generation. A good example is banana production in south-western Uganda, where some banana plots are more than 50 years old (Aloysius Karugaba, 1999). In such situations, improvements evolve slowly and production tends to stabilize at a fairly low level compared to ‘modern’ farmers who are in touch with research and extension. However, even among traditional farmers there is considerable farmer-to-farmer
learning. This particular feature can be used to establish farmer field schools and other approaches based on effective farmer participation and practical involvement.

**Policy aspects**

Official policies have effectively directed the national priorities in land and agriculture, for example, the development of cash crops such as tea and coffee in the well-watered highland areas. Such crops have become ‘national’ assets, enjoying considerable official protection and a package of incentives (research and extension, financing and marketing arrangements) because they generate considerable foreign exchange.

Similar attention is also given to cereals, particularly maize, wheat and barley, often pushing these crops into inappropriate agroclimatic zones at the expense of the traditional species and varieties. A good example is promotion of maize-growing in the drylands of eastern Africa, backed by many years of research but ignoring more suitable crop species. This trend has led to a narrowing of the food base, slowing efforts to ensure food security.

The case of maize illustrates this negative trend. Some of the reasons for the dominance of maize in Kenya include:

- Outside influence that raised the priority given to maize locally. Maize is considered a more tradable commodity on the international market. In addition, the region has also been a regular recipient of maize as food aid for many years and this has contributed to keeping it a high priority crop.

- Much more foreign technical and financial assistance has been given to agriculture for breeding, agronomy and popularization of maize as a staple food crop compared to indigenous dryland crops.

- Substantial support by the government, including a strong and sustained national research and extension programmes in favour of maize as opposed to the traditional crops, often officially referred to as ‘minor crops’.

- Long-term research funding for the development of maize varieties for the semi-arid areas instead of improving the ‘natural’ dryland crops such as millets, sorghums, root crops and trees that can provide fruits, wood and forage.

- Farm-level credit has also favoured maize, with the bulk of it going to maize, wheat and barley producers.
The development of milling and other processing as well as marketing facilities have given preference to maize, wheat and barley.

The overall result of the emphasis on maize is the significant change in eating habits in both rural and urban areas of Kenya and Tanzania. In many parts of these countries, food availability is generally defined in terms of the amounts of maize produced or imported instead of other food security assurance measures such as cash earned by the family. The reliance on a few annual cereal crops that are produced for home consumption is a recipe for hunger. The neglected indigenous crops that are economically advantageous are much more resilient in the face of changing market conditions and weather patterns.

**Market availability**

Smallholder producers are very sensitive to risks, partly due to their vulnerability and poor capacity to withstand them. In many cases, brokers not allied to farmers drive production of fruits and vegetables that could earn producers higher incomes. This makes it difficult for smallholders to directly access markets. Small-scale producers also lack the skills to add value to their produce, for instance by processing or preserving perishable produce to increase its shelf life and minimise risks. Basic school do not teach such skills and extension and research often come in well after the farmers have fall victim and lost interest in market-focused produce.

**Farmer organization**

Only a few countries in eastern Africa have organizations set up by farmers to increase their power to bargain for better prices of inputs, improve access to information and collectively lobby for supportive policies.

Ethiopia is one of the countries that lack such organizations. Instead, it has peasant councils that serve as the lowest administrative unit of government. The councils do not set up their own agenda or unite to form district or regional-level farmers’ organizations. The few commodity-based cooperatives are disorganized and do not have the capacity to serve farmers effectively.

In East Africa, the cooperative movement was a prime mover in agricultural production up to the 1980s. Cooperatives focused not only on production and marketing, but also on improving land management. However, since the early 1990s, the cooperative movement has become increasingly ineffective due to poor governance, a near collapse of world commodity prices and the inability to diversify
to other products. As a result, cooperatives have lost the capacity and experience gained over many decades, reducing farmers’ power considerably.

In response to the decline of cooperatives, farmers are looking for new organizational arrangements on a more informal basis, especially for production and marketing of perishable produce such as milk, fruits and vegetables. Through such informal common interest groups (CIGS), dairy farmers in the highlands have managed to supply large markets by organizing themselves and pooling milk from their farms to achieve scale. The CIGs involved are formed in response to existing markets for the specific products. However, in future, these informal organizations may coalesce or grow into larger (and formal) organizations at district, regional, national or cross-border levels.

RELMA has actively supported such common interest groups increase the participation of farmers in the market economy.

**Gestation period to yields**

In the absence of functional agricultural credit facilities suited to a majority of smallholders in rural areas, many farmers face a shortage of money for capital and short-term expenses. Therefore, they are forced to abandon enterprises such as growing of fruit trees and forestry that take longer to yield the first harvest. Instead, such farmers prefer activities and enterprises such as growing of seasonal crops that have quick returns.

Indeed, many farmers do not consider tree planting a commercial activity due to the long period it take for trees to mature. Yet conservation of natural resources often requires long-term investment whose full benefits are realized after many years. Since such benefits also accrue to the wider society, there is a big need for incentives to provide a bridge between short-term private interests of the individual farmer and the longer-term interests of the larger public.

Unfortunately, dependence on short-duration crops that require repeated and massive soil manipulation aggravates soil erosion where perennial crops could provide ground cover all year round. Therefore, it is necessary that governments come up with incentives to cover farmers for the long gestation periods for perennial crops production through appropriate incentives.
Resolving conflicts between production desires and limitations in soil moisture and depth

Agriculture in many areas of the region is limited by soil moisture deficits. The dry moisture regimes occur in all of the altitude zones, ranging from the dry hot lowlands to the dry alpine frost zones. Although aridity is not limited to lowlands, the vast arid and semi-arid areas (ASALs) experience unreliable rains that are erratic and concentrated in a few large storms. Much of the water is lost as runoff, causing soil loss through erosion.

The ASAL soils are shallow and often sandy, with a low water retention capacity. The high temperatures that led to high rates of evapo-transpiration make the situation worse. Traditionally, the farmers in these areas have depended on annual crops (cereals and pulses) that are highly vulnerable to moisture stress. Many farmers do not use fertilizers due to the moisture problem. The apparent conflict could be resolved through:

- Intensive use of manure and mulch coupled with slope-correction measures to maximize water holding capacity of the soils,
- More intensive water harvesting programmes
- Efficient technologies for irrigation.
- Introduction of better suited crops especially fruits and dryland forestry.

Size of holdings

On very smallholdings, farmers are forced to concentrate on food crops unless there is enough water for irrigation. Many of the smallholdings have low soil fertility due to continuous cultivation without adequate application of organic or inorganic fertilizers. Most of the smallholder zones cannot commercialize production for markets because they lack resources for the transformation. Furthermore, lack of effective farmer organizations limits the possibility of gaining from economies of scale by aggregating production from smallholdings.

With regard to food crops, livestock and woodfuel development, there is generally very little spatial planning of production on a watershed level. However, for a few cash crops, notably tea, coffee, sugar cane and cotton, the organization of farms has enabled farmers to produce quantities that are attractive to the local and international markets.
**Agroclimatic constraints**

Many farmers are growing crops in the wrong agroclimatic zones. Even when there are important production and land management innovations developed for the different agroclimatic zones elsewhere in tropical Africa, they cannot benefit the farmers because the way the zones are characterized differs among countries. The result is poor production, low yields and food deficits.

Modernization of agriculture in Sub-Saharan Africa will require classifying of agroclimatic zones for specified crops under specific land management interventions commonly shared by farmers in different locations of the same country, or in different countries. This will help farmers to borrow technologies and experiences that have worked successfully elsewhere and to produce crops that are well adapted to particular zone.

RELMA has tried to come up with harmonized agroclimatic zones to help solve the problem. Currently, profitable agroforestry innovations are studied and recommended by agroclimatic zones instead of by countries (Azene Bekele-Tesemma 2006, in print). The same approach has been used in a comparative assessment of agroforestry versus other land uses in five agroclimatic zones of eastern Africa (report in draft form). “Managing Land by Agroclimatic Zones” (Azene Bekele-Tesemma 2005), a chapter in *Managing Land, Technical Hand Book No. 36*, is another RELMA effort towards solving the problem.

**Market-focused development**

Most conservation programmes in eastern Africa (NSWCP, SCAPA, ULAMP, EHRS 1986) have not promoted market-focused watershed management. Their main thrust has been soil and water conservation and farm forestry. These long-running programmes have ended, giving way to new activities and projects focusing on promoting agriculture as a business driven by market principles including quantity, quality, continuity of supply, and credibility in negotiations with market dealers.

The issue of quantity is important in smallholder agriculture where farms run by individuals yield small amounts of produce that do not meet market requirements. In such cases, the traditional approach to achieving economies of scale in production is to get sufficient numbers of farmers to grow the same crop in an area and then market the crop through cooperatives with or without adding value. A good example is small-scale tea, coffee and dairy farming in the East African highlands. However, unfortunately, cooperatives been on the decline, as seen above.
Quality assurance is done by public bodies and exporters. Currently, smallholder farmers are struggling to achieve stringent standards required by importing countries, particularly rules enforced by the European Union. These standards are changing continuously and getting harder to achieve, partly because they are not commonly understood.

At the local level, farmers’ cooperatives and CIGs can also ensure attainment of high standards of production. For example, in the mango producing areas of Meru, Embu and Machakos districts of Kenya’s Eastern Province, farmers’ groups have been well trained in pest control in conformity with the EU standards. The farmers check on each other in a peer-review system that helps them improve standards over time. The farmers’ groups are also able to demand services such as training and inputs.

Organized groups that produce the same crop in a zone ensure continuity of supply. Such farmers share common production constraints -- soils, climatic conditions, distance from markets, state of infrastructure – and the group approach makes it easier to overcome these limitations. The groups also give farmers credibility in negotiations with market dealers and the power to deal with powerful customers.

Continuity can also be achieved through processing of the perishable produce such as fruits, vegetables, pulses or oilseeds into intermediate or final consumer products. This not only reduces fluctuations in the market prices due to changes in supply, but also increases farmers’ income.

To promote the market principles in smallholder agriculture, there is need for policy reforms at the macro-level to provide for systematic market research, development of links and other support measures. Policies should also aim to create market incentives for improved land management and accelerate adoption of new technologies.

The eastern Africa countries need to develop sufficient capacity to add value to agricultural produce, including agro-forestry products and livestock, to promote wealth creation and cut poverty by spreading new technologies for managing watersheds. For this to be achieved, national agricultural research and extension organizations should collaborate with industrial research organizations to create effective long-term technology development programmes focused on value addition and marketing.

**Monitoring impact with farmers**

The RELMA experience indicates that farmers judge the effectiveness of watershed management interventions if they can measure them in terms of productivity,
increased soil depth and soil fertility using variables they understand. This section discusses these variables.

**Productivity**

A basic factor that farmers consider in monitoring the impact of land management interventions is productivity. Farmers rate watershed management interventions as successful if production increases. They can do this easily by comparing annual harvests of crops such as cereals, tea, fruits and coffee. However, it is not so easy when it comes to production that is not in the form of annual harvests, such as woodlots.

For woodlots, RELMA successfully used comparative collar diameters of trees and shrubs. However, it was observed that if the product from perennial crops does not yield a usable commodity within a maximum of three years, farmers have difficulty accepting the crops as a successful intervention.

Another important way to measure impact is by comparing the productivity for each unit area in treated and untreated lands in the same watershed.

A common problem in monitoring impact with farmers is lack of data. Smallholder farmers hardly keep records and their judgment is mostly qualitative, expressed in terms of less or greater. Therefore, one basic area for capacity building support to improve monitoring and evaluating watershed management success in terms of productivity in instituting data recording and management systems both at household and farmers’ organization levels.

**Saving soil and its nutrients**

Farmers value soil as an important property and take measures to protect and improve soils on their land. They integrate indigenous and new approaches and technologies to counter erosion and retain soil on farms. In some areas, farmers trap the soil in floods and reclaim eroded land. They also use manure and mulch the soil to maximize its depth and fertility. However, there is need to evaluate the impact of the tools and practices used in saving the soil and enhancing its nutrients.

RELMA’s experience has shown that measurements that are abstract to the farmers, such as change in soil texture or the amount of soil in the water captured downhill streams and runoff plots, have little significance in convincing landholders that interventions have worked. Instead, more concrete measures should be used. For instance, farmers can seasonally and annually measure the height of pins pegged into
their plots as an indicator of eroded or accumulated soil. Experience has shown that even illiterate farmers can follow such monitoring practices.

The same is true in measuring soil fertility improvement. Laboratory measurements are too abstract for the typical farmer, but experience shows that farmers do appreciate soil fertility impacts indirectly in terms of the colour or size of plants. The quality and amount of harvest is another important measure of soil fertility.

In some instances, farmers associate soil fertility with resistance of the crops against diseases. Again, this is mostly a qualitative measure, pointing to the need to help farmers calibrate and quantify such indirect measurements.

**Economic returns**

Comparative economic gain for farmers is an important measure of watershed management interventions. In using this measure, it is sometimes necessary to ask farmers to take their harvest to the market to get genuine market prices, even when they do not intend to sell the produce. Farmers value comparative economic benefits gained in terms of market value of produce or the opportunity costs of standing crops.

However, farmers often do not value their labour as a cost of production. Even when they do, it becomes impossible to include accurate values in economic calculations because they do not keep records of how much they contribute. To support farmers monitor the impact of various watershed management interventions in terms of economic gain, there is need to develop simplified, easy-to-understand ways to collect data and use it to calculate benefits.

**Summary and recommendations**

RELMA’s experience shows the need to effectively connect the six-step watershed management approach to land management policies and put emphasis on market-focused development innovations. This will help the programmes to strengthen farmers’ economic access to food.

In addition, broad land use and agricultural policies should be formulated to guide researchers, extension workers and farmers on the best land-use options in line with agroclimatic conditions, market demands and the need for natural resource conservation.

Land and resource tenure (property rights regimes) should be given attention within watershed management areas to encourage investments in research and development.
Use of traditional institutions and indigenous knowledge

Experience has shown that to effectively reach the farmers and to create viable watershed management options, it is important to respect indigenous knowledge and combine it with the formal modern science and technology. Local traditional institutions should be part and parcel of the process. For instance, there is a lot of under-used indigenous knowledge about climate, soils, biodiversity and other production conditions that confront farmers.

A lot of research findings are abstract to extension providers and farmers alike. Such findings need to be married with indigenous knowledge and disseminated in a language that farmers and members of traditional institutions can understand. RELMA has been involved in this process by supporting the production of publications on that help put science into practice (Kithinji M, Critchley W., eds. 2002).

Farmer organization and empowerment

The management of natural resources requires strong and effective farmer organizations. Such organizations empower farmers and create a good foundation for the transfer, adoption and use of information on new technologies. They also help in negotiating for inputs at favourable prices.

Strong farmers’ organizations can be a conduit for services that meet felt needs. These needs include information to improve production and marketing, credit, and demand-driven approaches that ensure ownership and sustainability of interventions.

Farmers’ organization allows the use of participatory approaches that recognize local capacity and indigenous knowledge. It incorporates the aspirations and perceptions that influence decision-making, while giving farmers an important role in planning and implementation of watershed management activities. Such participation is important for the success, continuity and sustainability of the resource management programmes.

Often a successful watershed knits together many aspects of the people’s lives apart from purely technical issues. Many conservation and basic group production initiatives have widened into a social movement dealing with matters such as weddings, funerals, care for the elderly and the disadvantaged, and other issues in the community.

The initial natural resources focus also widens into a set of integrated activities such as the improvement of houses, provision of water and electricity, acquisition of improved tools, seeds and livestock, all in the name of watershed management.
Empowerment of farmers therefore allows farmers to demand services and to ensure the continued role of the state in supporting watershed development especially in the disadvantaged areas.

**Market orientation and value addition**

Farmers’ organization also allows for market-oriented production and development of the value-adding sector. Organized groups ensure that the smallholder production meets market requirements and facilitate training and capacity building. Farmer-to-farmer learning is also promoted through study tours and exchange programmes between watersheds and across countries to encourage adoption of new technologies and approaches.

**Farmers’ production in relation to cash value**

Grains dominate food production and consumption in most countries in the region. Yet the growth requirements and yielding potentials of grains are generally at variance with the climatic and soil conditions. As a result the production levels are often too low to meet the national demand for food.

Food security is having physical and economic access to food – the ability to buy it. However, countries in Africa have continued to invest their resources in grain production even in areas where the expected yield is significantly low instead of promoting alternative crops that can give farmers money to buy food from surplus-production areas. As a result, many of the countries have experienced serious food insecurity over the past few decades, regardless of their efforts to produce grains. Ethiopia, Kenya, Tanzania and Zambia have suffered the most. The dominance of

![Figure 1 Food diversity in Eastern Africa](image-url)
cereals in these countries is illustrated in the Figure 1 below and Appendix 2. Also note that these are the countries where cereals are dominant and in many cases, “maize is food and food is maize”.

The features described above are important in considering land management and agricultural production at household and watershed levels. The dominance of cereals over cash-source production has a direct consequence on poverty and persistence of hunger in eastern Africa. From Figure 1 above, it is only in Uganda where production is not cereal-biased and food deficits are rarely as severe as in the other countries in the region, especially Kenya and Ethiopia.

In RELMA’s view, watershed management should incorporate more investment in research and development to improve production, value addition and marketing of cash-value crops alternative to cereals.

**Research support in watershed management**

Watershed management requires the support of research. In the eastern Africa, there have not been sufficient efforts to link watershed management with research -- or to build research into watershed management. Watershed projects have not been used as on-farm sites for research designed and implemented with significant involvement of farmers and extension workers to produce site-specific technological solutions. This leads to problems in adoption and up-scaling of research findings within specific watersheds.

There is also the question of up-scaling technologies and approaches beyond a designated watershed. At the same time, researchers were unable to relate research activities to the real problems facing farmers or to capture the locally developed or modified technologies. Yet there is a need to give technologies appropriate technical and scientific definition and to disseminate them widely.

**Institutional collaboration**

Watershed management and development requires the collaboration of a wide range of farmers’ organizations as well as extension and research institutions at various levels. This gives implementers access a wider technical resource base, creates better information flows and encourages mutual learning.

Watersheds serve as a confluence between lands and communities, providing ample opportunities for members to share complementary expertise. A watershed contains producers (farmers), possibly actors that add value to produce, traders and consumers. This makes watersheds ideal for government, development, industry, trading,
information, and education institutions to test their joint efforts to make a difference. Watersheds are also a good ground for learning and demonstration of expertise.
Appendices

Appendix 1: Low, medium and high management levels and the respective socio-economic characteristics of smallholdings

<table>
<thead>
<tr>
<th>Socio-economic characteristics</th>
<th>Low (little land, no water for irrigation)</th>
<th>Medium (more land, 2 - 8 acres, limited irrigation)</th>
<th>High (larger farms, over 8 acres, regular irrigation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited land</td>
<td>More land</td>
<td>More arable land</td>
<td></td>
</tr>
<tr>
<td>Production for subsistence</td>
<td>Focus beyond subsistence: some rainfed horticulture</td>
<td>Production for cash: more land under horticulture, rainfed and irrigated</td>
<td></td>
</tr>
<tr>
<td>Little or no livestock</td>
<td>Keeps some cows and dairy goats</td>
<td>Good dairy cows as a form of enterprise diversification</td>
<td></td>
</tr>
<tr>
<td>No purchased fertilizers</td>
<td>Uses some fertilizer on horticulture</td>
<td>Fertilizers as well as animal and compost manures</td>
<td></td>
</tr>
<tr>
<td>Little or no surplus for market: little cash from the farm</td>
<td>Surplus production is marketed to meet some cash needs</td>
<td>Horticulture and fruits for cash, regular surpluses of maize and beans for sale</td>
<td></td>
</tr>
<tr>
<td>Poor planning</td>
<td>Poor long-term planning</td>
<td>Good long term plan and good record keeping</td>
<td></td>
</tr>
<tr>
<td>Use of own seed</td>
<td>Certified seed each season</td>
<td>Uses improved seeds</td>
<td></td>
</tr>
<tr>
<td>Poor yields</td>
<td>Yields are good</td>
<td>High crop yields</td>
<td></td>
</tr>
<tr>
<td>Poor coping mechanisms</td>
<td>Diversified production – better capacity to cope</td>
<td>Diversified production</td>
<td></td>
</tr>
<tr>
<td>Low soil fertility</td>
<td>Animal manure to maintain soil fertility</td>
<td>Keen attention on soil fertility – fertilizers and manures</td>
<td></td>
</tr>
<tr>
<td>High poverty levels. Serious food deficits</td>
<td>Produces sufficient food for the household</td>
<td>Emphasis on cash production</td>
<td></td>
</tr>
<tr>
<td>Heavily dependent on off-farm employment</td>
<td>Enough occupation for the head of the family</td>
<td>Enough labour</td>
<td></td>
</tr>
<tr>
<td>Work left to women</td>
<td>Head of household present</td>
<td>Head of family as manager</td>
<td></td>
</tr>
<tr>
<td>Inadequate labour</td>
<td>Adequate labour</td>
<td>Use of hired labour</td>
<td></td>
</tr>
<tr>
<td>Poor land management</td>
<td>Better management</td>
<td>Land well managed</td>
<td></td>
</tr>
<tr>
<td>Poor conservation</td>
<td>Land tends to be fairly well conserved</td>
<td>Well conserved: terraces stabilized with grasses for fodder</td>
<td></td>
</tr>
<tr>
<td>Increased land degradation</td>
<td>Land degradation minimal</td>
<td>A high level of soil and water conservation</td>
<td></td>
</tr>
<tr>
<td>Little tree planting</td>
<td>Few trees planted</td>
<td>Trees include <em>Grevillea robusta</em> and <em>Eucalyptus sp</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fruit trees: mango, avocado, macadamia</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water harvesting, field and roof</td>
<td></td>
</tr>
</tbody>
</table>

NB. Issues of education/literacy levels, health, family size, not considered.
## Appendix 2: Food diversity in Eastern Africa – percentage contribution of various food groups

<table>
<thead>
<tr>
<th>Countries</th>
<th>Cereals</th>
<th>Sugar</th>
<th>Vegetable oils</th>
<th>Roots/tubers</th>
<th>Pulses</th>
<th>Animal products</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethiopia</td>
<td>70.8</td>
<td>2.1</td>
<td>3</td>
<td>4.2</td>
<td>10.4</td>
<td>6.7</td>
<td>2.8</td>
</tr>
<tr>
<td>Tanzania</td>
<td>70.3</td>
<td>7.6</td>
<td>2.3</td>
<td>9.9</td>
<td>1.7</td>
<td>4.9</td>
<td>3.3</td>
</tr>
<tr>
<td>Kenya</td>
<td>49.8</td>
<td>11.3</td>
<td>8.3</td>
<td>8</td>
<td>3.7</td>
<td>13.6</td>
<td>5.3</td>
</tr>
<tr>
<td>Zambia</td>
<td>45.6</td>
<td>2.4</td>
<td>4.8</td>
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FAO 1996.
References


Working papers in this series

1. Agroforestry in the drylands of eastern Africa: a call to action

2. Biodiversity conservation through agroforestry: managing tree species diversity within a network of community-based, nongovernmental, governmental and research organizations in western Kenya.

3. Invasion of *prosopis juliflora* and local livelihoods: Case study from the Lake Baringo area of Kenya

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Who we are

The World Agroforestry Centre is the international leader in the science and practice of integrating ‘working trees’ on small farms and in rural landscapes. We have invigorated the ancient practice of growing trees on farms, using innovative science for development to transform lives and landscapes.

Our vision

Our Vision is an 'Agroforestry Transformation' in the developing world resulting in a massive increase in the use of working trees on working landscapes by smallholder rural households that helps ensure security in food, nutrition, income, health, shelter and energy and a regenerated environment.

Our mission

Our mission is to advance the science and practice of agroforestry to help realize an ‘Agroforestry Transformation’ throughout the developing world.