African Highlands Initiative

Situation Analysis for the Intensively Cultivated Highlands of East and Central Africa

(ABBREVIATED VERSION)

Part A:

An Input into the AHI Strategy for ASARECA 2005 – 2010

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Preface

ASARECA has had each of its networks, programs and projects set priorities. This is a step-wise process that entails: making a situation analysis which leads to potential issues/constraints for research; logical choice of potential research themes related to program mandate and to NRM meso-strategy; scoring of potential for these research themes to make a difference in the next 5 years or so. This then becomes the priority areas for AHI research in the near future. AHI has had numerous stakeholder consultations and evaluations over the 9 years it has been operating and has set its course accordingly. This document further refines the situation analysis presented in the NRM strategy for ASARECA (2005-2015) (Hatibu et al 2004), and for AHI (Wangati and Loevinsohn 1994; Alumira 2000; Stroud 2003).

This particular analysis adds value in two ways: (i) it identifies 'pathways' and potential ways that INRM can contribute towards achieving the ASARECA objectives; and (ii) there is an improved spatial analysis coupled with what AHI has learned about the highlands over the last 9 years that improves the description of the issues. From the analysis emerge possible combinations of solutions (via research themes) for issues in highland relatively homogeneous areas having similar dimensions of biophysical, social and human determinants, which are called "Livelihood Agro-ecosystems".

This document **(Part A)** provides an abbreviated version of a situational analysis of the complex of socio-cultural, economic, political, environmental and institutional issues that contribute to the degradation of the natural resource base of the intensively cultivated highlands of East and Central Africa (ECA) where the African Highlands Initiative (AHI) has been targeting its research since 1995. The comprehensive situation analysis as a more extensive review is also available and can be requested from AHI. This document provides a review that highlights constraints and opportunities related to the poverty-degradation nexus in this ecoregion. The assessment also reviews various approaches' used in INRM, underscoring their strengths and weaknesses. This particular analysis has been built up over the years and has led AHI and others to develop and use the 'INRM approach' that addresses the weaknesses of other approaches and tries to address reasons for non-adoption of NRM technologies and solutions. The overall aim is to help alleviate poverty by enhancing agricultural production and lead to more sustainable livelihoods.

The research themes and LAEs are described in a separate document (**Part B)**. Priority setting will be done through scoring their contribution towards ASARECA's objectives: economic growth, social welfare, environmental quality, regionality and contribution towards capacity building. AHI will use this information to refine its strategy, highlighting major implementation mechanisms and principles for carrying out the research.

Part C describes the scoring procedure and analysis. It describes potential pathways that the highland livelihood agro-ecosystems and research themes can lead to the ASARECA objectives. Stakeholders involved in the priority setting process for AHI are asked to use these documents (**A, B and C**) to may make informed choices regarding the priorities selected. We are calling upon the assistance of various types of expertise and perspectives, so as to glean views generated from different experiences across the region.

This document is written to cater for a multi-disciplinary readership and seeks to provide a platform where actors from all disciplines can gain a comprehensive understanding of the complexities involved in INRM issues including the impacts of problematic conditions and factors and their solutions, and to envision their potential role in future work in this regard.

1. Introduction

The African Highlands Initiative (AHI) was launched in 1995 and has a dual role as an ASARECA regional research program and as a CGIAR ecoregional program. It is hosted by the World Agroforestry Centre (ICRAF). AHI operates as a research for development (R4D) consortium using partnerships and stakeholder participation to improve the livelihoods of poor people living in the highlands of East and Central Africa. The aim of AHI is to reverse natural resource exploitation and degradation while improving livelihoods. AHI was born from a desire to enhance impact. It has been working towards improving R4D practice and policies by developing and testing an integrated R&D approach that combines technological, social, economic and institutional innovations and methods aimed at improving R&D support services, development strategies and policies, and local capacities to manage their natural resources while deriving their livelihoods.

In ECA, there have been significant amounts of research in the highland ecosystems; however, impact has been limited. The reason being that there are deficits in the 'way R&D was being done' rather than due to major technological gaps (Wangati and Loevinsohn 1994). This analysis (presented in full in this document) has led AHI to develop and test new ways of working. The situation in the highlands is particularly grave and this is why it became the target of the AHI operations. Thus, AHI's strategy and overall research focus has been 'how' to implement the ecoregional approach. This approach has evolved through iterative consultation, practice, reflection and evaluation involving implementers, beneficiaries, and other stakeholders. National and international agricultural research entities that bought into AHI's mission and vision have been the main partners in the consortium.

AHI, as an ASARECA program, has been working in 5 ASARECA countries: Tanzania, Kenya, Uganda, Ethiopia and Madagascar, each of which expressed early interest and commitment and has the ecoregion within its boundaries. AHI is considered a program rather than a network because capacity to use an integrated R&D approach to solve NRM and agricultural productivity issues is weak. Partners involved in AHI include several of the IARCs, NARIs, universities and locally NGOs, extension and local governments. AHI has been working in pilot watershed sites to test methods, has created learning teams and 'models' for scaling up. AHI promotes the combination of formal and action research, develops capacity in research for development including developing research and development methods, and solicits participation of communities and development partners on a daily basis. Cross-country or regional analyses and synthesis provides cross site/country learning, regional public goods that are generalizable, and has built a cadre of R&D practitioners and managers who are able to do and manage their work differently. Although AHI is focused on solving issues and addressing opportunities in the highlands, many of its products and methods are generic and can be used in any ecology.

Currently, AHI has two major thrusts, INRM approach development and INRM institutionalization, with 4 main strategic results areas:

1. INRM innovations developed and utilized to advance community-based participation in watersheds;
2. Development strategies, policies, and practices for INRM are facilitated;
3. Supportive institutions and institutional arrangements for INRM are piloted;
4. INRM information that enhances knowledge base of R&D actors is provided.

In 2004, a group of ASARECA NRM Networks and Programs - Trees on Farm (TOFNET), Soil and Water Management (SWMNET), Animal Agriculture (A-AARNET), Genetic Resources Management (EAPGREN), and AHI – developed an NRM strategy for ASARECA. This is part of the overall regional strategy for the next 5 years and helps to create the focus for implementation of the ASARECA Conceptual Framework. It also serves to focus the strategies and priorities of each NRM network or program using its own comparative advantage. An overview of the NRM strategy and results are presented in Part B, Annex 3.

2. Review of the Research Domain

A condensed version of the situation analysis (Part A) is provided here and leads to the description of the research themes and their application to the LAEs described in Part B.

2.1 Overview

Why focus on NRM and livelihoods in the highlands? The ECA highlands and its populace are challenged with the following complex of issues that we call the 'poverty-degradation' nexus.

Farmers have very small land holdings and in some cases there is high incidence of fragmentation and untenable land tenancy regimes. Generally, in very intensive areas having high population densities, farmers are unable to produce enough food or derive income from sales to buy food given climate, soil and water, and market conditions. This means that they are food insecure. This limited income also translates into limited investments in NRM, such as conservation measures and maintenance of land cover, which leads to more erosion risk; in fertility amendments, which leads to nutrient mining; or in pest control, which is exacerbated by limited ability to rotate crops or keep up soil fertility maintenance. Therefore, yields are declining and the NR base is being eroded or mined.

Population pressure causes people to expand into marginal hilly areas, which increases soil and water loss, and destroys unique habitats due to encroachment on wetlands, forested and protected areas, and through burning. By eliminating microhabitats within agricultural lands and removal / disturbance of highland forest ecosystems biodiversity is declining. There is weak protection of common property or nationally owned forests, poor land tenure policies and limited incentives to invest in conservation. Often highland people have to pay for maintaining environmental services that benefit lowlanders.

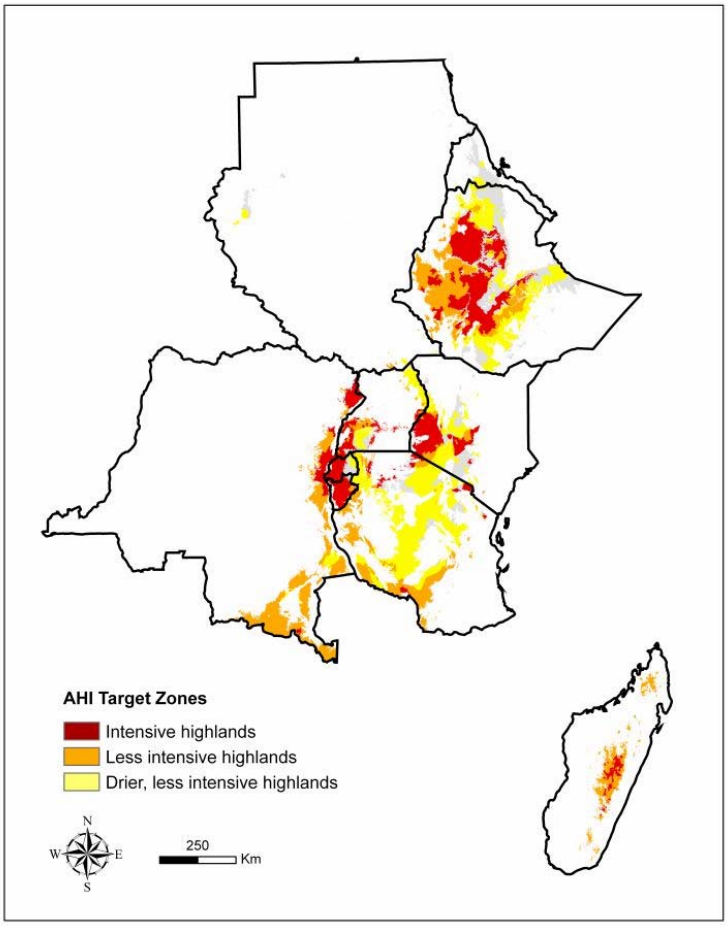
There is increasing scarcity due to inefficient use of water for agriculture, livestock and other competing uses within the mountains themselves and along mountain to lowland gradients. There is also declining ability of livestock to positively contribute to the maintenance of the system due to poorly intensified feed systems, poor links to markets and break down of traditional management systems. In some systems this is causing decline of grazing lands and leading to an increased number of conflicts. Water use and livestock management issues interact with collective management of grazing and crop land and water resources.

Social welfare issues also interact with livelihoods and NRM: inequitable gender relations, health and nutrition issues and their ensuing impacts (malaria, HIV/AIDS) result in declining labour sources. These are challenged by limited availability of health and education services. Given topography and vastness of mountain areas, taking Ethiopia as a case in point, development and associated information and communication is limited. Also, there are relatively poor public services and infrastructure seriously limiting access to inputs, credit, and markets.

The interplay of these conditions limits people's ability to cope, is leading to increased marginalization of some groups, and is exacerbating poverty in the highlands. The economic conditions and policy environment have not provided the necessary incentives to highland dwellers to make long-term investments to better manage their natural resources. Limited ability to invest is exacerbated by limited credit, low local wage rates and increased landlessness. HIV-AIDS has created additional stress, where families are loosing their assets and labour. There is an increase in migrant labour to seek employment elsewhere, which in turn limits family labour to undertake the farm work. Inequitable gender and power relations and inadequate policy formulation, implementation and governance reduce stakeholders' capacity to participate in INRM.

It is hypothesized that limited impact on these complex challenges is largely due to limited sharing and management of knowledge, information and technologies, coupled to the continued use of

reductionist[1] research approaches that are not augmented with systems and more holistic approaches. This analysis led AHI to work on an INRM approach, which is still being proposed as a potential entry point into organizing research for development and ensuring that the most limiting factors are tackled holistically and systemically. It attempts to link diverse scientific and local knowledge coming from a diversity of perspectives by working through different institutional arrangements, in an attempt to strengthen a collaborative approach towards forming holistic research for development strategies and thrusts that will guide INRM initiatives in ECA highland regions for the next decade. Innovation systems approaches, such as an INRM approach, require creativity, flexibility and multi-institutional arrangements at various levels and often public and private sector organizations are not yet accommodating enough, thus, there are institutional barriers and competency levels that need work.



Legend

Zone	Description	Population Density	Annual Rainfall	Relief
1	Intensive Highlands (red)	≥ 100/km2	>= 1000 mm/year	>= 1200 m
2	Less intensive highlands (orange)	< 100/km2	>= 1000 mm/year	>= 1200 m
3	Drier, less intensive highlands (yellow)	< 100/km2	Between 600 and 1000 mm/year	>= 1200 m
4	Dry highlands	≤ 100/km2	< 600mm / year	>= 1200m

[1] Reductionist: A philosophy dictating that the nature of complex things can be reduced to smaller fundamental things. This is said of observed phenomena, theories, explanations, meanings, etc. Scientific reductionism refers to reductionism employed in the scientific process.

The above map illustrates the highland ecoregion, relief being ≥ 1200m. Zone 1 (red) is where there is adequate rainfall and a high population density. Zone 2 (orange) is where there are slightly fewer people but still adequate rainfall while zone 3 (yellow) is also having slightly fewer people, but less rainfall, between 600-1000mm per annum. The grey highland zone is where the rainfall is less than 600mm per annum.

Table 1: Population levels and areas in highland zones in ECA

Zone	Area (km2)	Population	Density (pop/km2)
Drier, less intensive highlands (yellow)	408,683	14,228,140	35
Intensive Highlands (red)	313,503	73,337,815	234
Less intensive highlands (orange)	428,030	15,891,005	37
Other Highlands (grey)	242,922	26,430,742	109

Source: CIESEN, 2004, GPW III Beta; Map & data by A Notenbaert (2005)

2.2 Population pressure and carrying capacity

The highlands[2] of ECA occupy 23% of the total area of ECA, experience relatively high annual rainfall, and generally boast productive soils relative to the adjacent marginal lowlands (ICRAF, 1994). Given this endowment, the highlands have been a major source of food and nutritional security for countries having significant highland areas producing more than 50% of staple foods (maize, beans, bananas, wheat, barley, teff, rice and dairy products). These areas also produce important export crops mainly tea, coffee, and horticulture that contribute to foreign exchange (ICRAF, 1996). These highlands have the highest concentration of human population and settlement in the ECA accounting for nearly 53% of the population, 70-90% of which are involved in farming (ICRAF, 1998).

Table 2: Land and population statistics

Country	Total area in highlands[1] (km^2)	Total population in highlands ('000)	Density (pop/km2)
Burundi	22,629	5,467	242
Kenya	132,766	21,799	164
Madagascar	59,071	5,117	87
Tanzania	331,211	14,038	42
Eritrea	25,158	2,110	84
Rwanda	24,253	7,644	315
Ethiopia	533,825	54,409	102
Uganda	68,572	9,754	142
Sudan	15,425	185	12
DRC	180,228	9,364	52

[1] >1200m Source: CIESEN, 2004, GPW III Beta Maps & data by A Notenbaert (2005);

[2] Highlands are defined here as being ≥ 1200m and having characteristic steep slopes, valleys and generally undulating topography.

Table 3: Average Household Sizes in AHI Benchmark Locations

Pilot location	Area (km^2)	Number of households	Household size (average)	Total population	Population Density (Persons/$km^{2)}$
Rubaya (Kabale)	114	6,685	7	46,800	410
Emuhaya (Vihiga)	9	1,000	8	8,000	889
Gununo PA (Areka)	14	700	7	4,900	339
Galessa PA Ginchi	14	446	5	2,003	144
Sahasoa (Fianarantsoa)	15	220	6	1,320	220
Kwalei (Lushoto)	40	515	8	4,120	102
Ambohibary Antsirabe)	37	700	6	4,200	114
Kianjuki (Embu)	1.2	100	7	700	583

Source: Participatory Rural Appraisal reports for the respective pilot locations (1997-98); David (2003)

Average farm size in the highland regions of ECA are small ranging from 0.5 to 1.4 ha per household and given household sizes of 6-8 persons, the amount of land per person is very small (0.07 – 0.23ha) (ref tables 2 and 3). Locations (Ethiopia and Madagascar) having only one season are more constrained. Current livestock and human population densities on these land holding sizes given their production potential raises the issue as to whether or not these farms are going to be viable or not in future and what further diversification and intensification and livelihood strategies might be required to keep people out of poverty in future. Increasing returns to land and labour through higher value crops and / or added value to commodities is an obvious strategy, among others. Given the population densities and farm sizes per household, there are increasing challenges to meet all needs as well as the escalating strain on natural resources.

Table 4: Average Farm Size in AHI Benchmark Locations

Pilot Location	Average Farm Size (ha)	Farm land (ha) per person	Number seasons per year
Gununo PA (Areka)	0.5	0.07	1-2
Kashambya (Kabale)	1.1	0.16	2
Galessa PA (Ginchi)	2.9[1]	0.58	1
Sahasoa (Fianarantsoa)	1.4	0.23	1
Kwalei (Lushoto)	1.3	0.16	2
Kianjuki (Embu)	1.2	0.17	2
Emuhaya (Vihiga)	1.0	0.125	2

Source: Participatory Rural Appraisal reports for the respective pilot locations (1997-98)
[1]Inclusive of grazing area 0.9ha holding for 2 cattle, 1 donkey, 8 shoats

Table 4 shows that the highest cattle densities, falling in the range of 103-113 head of cattle/km^2, tend to occur where there are high densities of people who are used to keeping livestock as well as where there are less intensive systems; for example, in Ginchi, Areka, and Vihiga districts. As systems intensify with markets for dairy and where hoe culture tends to dominate in perennial crop systems, where the terrain is hilly or where land size is small, the zebu becomes less dominant. An important aspect to note is that under current management conditions stocking rates are usually kept above the carrying capacity. This management strategy is used to spread risk and to satisfy various needs / roles that livestock provide, rather than to optimize productivity per animal. If a market economy gained importance, then management strategies might change resulting in lower stocking rates. High numbers of livestock compete with people for what the land provides and space available.

Table 5: Cattle Densities in Relation to Human Population by Benchmark Location

District (country)	Human population density	Cattle population density (# cattle/Km^2)	# Cattle per capita
Dendi (Ginchi, Ethiopia)	111 (low)	80	0.7 (high)
Bolosso Sore (Areka, Ethiopia)	339 (medium)	103	0.3 (medium)
Vihiga (West Kenya)	922 (high)	113	0.14 (low)
Embu (Central Kenya)	730 (high)	28	0.04 (low)
Kabale (SW Uganda)	271 (medium)	25	0.09 (low)
Lushoto (Tanzania)	102 (low)	33	0.32 (medium)
Antsirabe (Madagascar)	201 (low)	18	0.08 (low)
Fianarantsoa (Madagascar)	94 (low)	-	-

Source: Derived from Corbett *et al*, 1997/ (ICRAF GIS Lab., 2000)

The level of intensification linked to land pressure heightens the challenge to better integrate livestock and crop production in a manner that benefits both enterprises and NRM practices in the different scenarios and farming systems. Thus, land use and productivity solutions need to integrate and take cognizance of ecology (species suitability), systems fit including farm size and location (location and niches for feed), culture (how livestock are used and kept), labour availability (level of intensification possible), institutional arrangements (collective management of feed resources in some cases), markets (possibility of sales of products), infrastructure (accessibility of inputs, services and markets), R&D support, and policy (for example land tenure issues).

A major issue arising in highlands is the interplay between rising population density, shrinking land holding size and livestock numbers, which are not declining in relation to the shrinking resource base. Livelihood strategies and asset management are changing or need to change as families repeatedly face food deficits, livestock deaths, and degradation. From the shear numbers of humans and livestock trying to eek a living from the area available, productivity increases alone of traditional cereal crops will not solve food, feed and cash needs. The carrying capacity (ability to provide kcal needed to support the human and livestock units) is not sufficient. This has implications for R&D strategies undertaken to alleviate poverty, hunger and degradation.

In summary, one of the main reasons for working in the intensively cultivated highlands is because of the high and rising population densities that are based on small farms. For each generation available land is less, resulting in increased need for intensification and increased problems to rotate crops and maintain soil fertility resulting in nutrient mining and build up of pests and diseases. In many areas, there simply is not enough land for the population resulting in landlessness. Adequate integration of livestock in farming systems and often decline of livestock units has yet to be achieved limiting NRM and livelihood strategies. The demographic situation is problematic, requiring creative innovations from all sectors.

2.3 Agro-Ecosystems and Associated Natural Resource Base in Mountain Areas

Highland areas of ECA are very diverse given a number of ecologies, histories, levels of development, and socio-economic factors. There are 17 highland agro-ecologies within two major classifications, as classified by IGAD/FAO through integrating length of growing periods and onset, temperature, soil fertility and water holding capacity, topography, crops, and livestock. FAO's two classifications of highlands are: marginally productive which are dry semi-arid and currently not worked in by AHI, and productive, which has a number of determining variables (where AHI is working). The heterogeneity of mountain areas is both challenging and offer opportunities. Altitude-climate gradients provide a wide range of ecologies for the production of temperate fruits, dairy, coffee and tea as well as agroforestry systems and biodiversity. The hilly landscape also forms important watersheds, which provide water for large areas of the lowlands (Gichuki, 2002).

By grouping highland areas and their farming systems into the following broader livelihood agro-ecosystems (LAEs) (which are not exclusive of each other) related to their endowments and other characteristics (market access, nearness to conservation areas, etc), potential issues and opportunities emerge (Table 5). Some conditions require greater policy interventions and greater investment support (higher poverty, less natural resource endowment, crisis affected, more distant from markets); may require tailored enterprise development to be competitive (distance from markets); could benefit from diversification; etc.

Both zebu and exotic breeds of cattle, as well as goats, sheep, pigs and poultry are kept throughout the highland eco-region. Production objectives are similar across the area: food security; cash income; draught power; transportation; risk aversion and savings bank; manure production for enhancement of soil fertility; and as a social good. Feed sources function as soil and water conservation barriers, provide organic matter, and can assist in improving soil fertility. Thus, the integration of livestock is exceedingly important. In Kenya, Tanzania, Uganda, Ethiopia and Madagascar, farmers consider ownership of livestock as a 'wealth indicator' (AHI 1998). Poor farmers own no cattle or have limited access to livestock. In the intensive enset farm systems of Ethiopia (upon which 13 million people rely), grazing areas are kept by non-livestock owners so they can trade feed for services provided by owners, even though crop production areas are constraining. Farmers here say that if grazing area size decreases, it would signify the end of their life as farmers. Under current management conditions among rural poor households, animal feed is almost always in short supply. Domestic animals are almost always underfed. Feed constraint is the top issue affecting animal production and keeping. By implication, load or stocking rates are higher than the carrying capacity particularly if the farmer's goal is to maximize productivity per animal.

Table 6. Highland Scenarios determined by ecology, access to markets, and natural resource endowment with associated constraints and opportunities

Type of highland zone	Locations (examples)	Constraints & Issues	Opportunities & Potential Solutions
Buffer zones of national parks and conservation areas	• Eastern Arc Mountains • Rwenzories • Bwindi Impenetrable Forest, • Mt Elgon national park • Areas in Madagascar • E DRC • NW Rwanda	• Conflicts between livelihood & conservation objectives • Indigenous forest people & their issues; • Exploitation of biodiversity • Limited livelihood options for those depending on the conservation area	• Ecotourism • Joint forest management • Enterprises using unique biodiversity • Tree crops • Compensation arrangements for conservation
'Water towers', highlands surrounding lake basins & their surrounding lowlands	• Mt Elgon • Rwenzories Rwengueries • Mt Kilimanjaro • Usambara & Pare Mtns • Ulugurus • Lake Tana highlands & basin • Lake Victoria highlands & basin • Lake Tanganika highlands & basin	• Degraded sloping land & siltation of lowlands & basins • Conflicts over water rights • High costs of conservation for highlanders	• Water sales • ES payments / compensation • Cross border trade • Settlement in lowlands • Improved integrated watershed management • Improve management of communal lands
Intensive & highly diversified systems with steep slopes, relatively *good* soils/rainfall but *distant* from major markets	• S, W and N Ethiopia • S, N Madagascar • Parts of Usambaras & Ulugurus • Rwenzories • NE DRC	• Productivity issues • Nutrient mining and erosion • Marketing • Limited livelihood options • Limited ways to add value to products • Input supply problems / costs	• Non-perishable / easy to transport products for distant markets • Multiple/diversified products for local markets • NRM solutions • Productivity increases • Improve integration of livestock
Intensive and highly diversified systems with steep slopes, relatively *good* soils/rainfall and *close* to major markets / population centres	• SW Uganda • Mt Kenya • Parts of Mt Elgon • Parts of Mt Kilimanjaro • Most of Rwanda • Eastern DRC • C Madagascar • Parts of Usambaras & Ulugurus	• Productivity issues • Nutrient mining and erosion • Marketing • Limited ways to add value to products • Competition for labour	• Multiple/diversified products for diversified markets • NRM solutions • Productivity increases • Pursue alternative livelihood options like trading • Cheaper inputs • More efficient marketing • More opportunities to add value to products • Improve integration of livestock

Type of highland zone	Locations (examples)	Constraints & Issues	Opportunities & Potential Solutions
Intensive and highly diversified systems with steep slopes, relatively *poor* soils/rainfall and *close* to major markets / population centres	• Highlands in Madagascar • Degraded, poor nutrient soil areas in S Ethiopia • part of Ulugurus • Usambaras & Pares • N Ethiopia • Eritrea	• Productivity issues • Nutrient mining and erosion • Marketing • Limited ways to add value to products • Burning & extreme degradation of upper slopes • Periodic drought / water shortage • Greater investments needed to increase production • Competition for labour	• Investment & restoration of degraded areas • Augment nutrients with subsidized/ improved input supplies • Multiple/diversified products that can grow in less than optimum conditions or in niches for diversified markets • Water harvesting & improved management of run off • By laws that limit burning & improve collective action • Improve integration of livestock
Intensive and highly diversified systems with steep slopes, relatively *poor* soils/rainfall and *distant* from major markets	• Parts of Madagascar highlands • Parts of Burundi • Parts of Rwanda • Parts of Eritrea • Parts of C & N Ethiopian highlands	• Productivity issues • Nutrient mining and erosion • Marketing • Limited ways to add value to products • Burning & extreme degradation of upper slopes • Periodic drought / water shortage • Greater investments needed to increase production	• Investment & restoration of degraded areas • Augment nutrients with subsidized/ improved input supplies • Multiple/diversified products that can grow in less than optimum conditions or in niches for local markets • Water harvesting & improved management of run off • By laws that limit burning & improve collective action • Improve integration of livestock • Lobby for policy support given limited options
Extensive less diversified systems with moderate to steep slopes, relatively *poor* soils, *one* growing season & frost hazard, *distant* from major markets	• C & N highlands of Ethiopia • Eritrea • Southern Madagascar highlands	• Limited enterprise diversification given harsh conditions • Limited livelihood options • Limited storage heightens risk & cost • Nutrient mining & erosion • Over grazing • Productivity issues • Limited fuel wood • High transaction costs to markets	• Diversify enterprise options • Intensify valleys and niches • NRM solutions • Productivity increases • Improve storage facilities • Intensify livestock feeding & management systems • Integrated watershed management • Identify niche markets & labelling • Lobby for policy support given limited options • Strengthen collective action &

Type of highland zone	Locations (examples)	Constraints & Issues	Opportunities & Potential Solutions
			communal property management • Improve land tenure arrangements • Policy incentives and support • Greater investment in infrastructure & market outlets
Peri-urban and nearby highland areas greatly influenced by urban centres	• Addis • Nairobi • Antsirabe & Tana • Kigali •	• Drain of labour • Nutrient mining • Intensification • Value adding possibilities limited • Small areas of land • Competition	• Markets • Diversify crop & livestock enterprises • Improve quality & seasonal production of strategic products • Processing opportunities • Pursue alternative livelihood options • Inputs supply better
Vulnerable areas & groups due to climate, war, health issues, increased competition for scarce resources, very high levels of poverty, and NR exploitation / condition	• W DRC • Rwanda • N Ethiopia • Eritrea • Burundi • W Kenya	• Cereal production & NRM mined soils • Insecurity • Dependency syndrome • Increased HIV and other health problems • Traditional coping strategies eroding • Conflicts over land and valuable resources • Exploitation of forests, water, land • Landlessness • Low wage or compensation rates • High % female headed households with limited labour	• High value enterprises as alternative livelihoods to war • Renewed coping strategies • Improved development / aid strategies to limit dependency • Policy support & strategic subsidies • Lobbying for better and cheaper health care • Labour saving NRM technologies • High value, low labour enterprises • Increased fuel sources • Improved integration of livestock feeding & management systems • Conflict resolution & negotiation mechanisms & ability • Improve collective action & social support systems • More accountable systems for managing resources & decreasing theft • Better governance • Alternative livelihoods for landless people

There are various livestock keeping systems used in the highlands. They are usually determined by the 'space' available for livestock and customs; thus, systems vary in terms of the extensiveness or intensiveness of the system ranging from extensive grazing (highlands of Ethiopia), to tethering and seasonal grazing on non-cropped areas (more populated areas in Ethiopia, Uganda, Madagascar), to stall feeding or zero grazing (Kenyan highlands).

Farmers in all highland areas use the catena and special niches as a strategy to spread risk, capture off-season markets, and optimize returns. Given that farm size is so small, use of niches to the optimum is very important. These are 'opportunity' spots that can be targeted for improvements and interventions, including policy interventions. Some examples include:

- Use of valley bottomland for rice (Madagascar) and off-season high value crops. This can be an opportunity for intensification (Ethiopia);
- Different crops are allocated to different parts of the landscape; e.g. use of outfields for cereal and root crop production (Ethiopia), bananas on sloping lands (Lushoto), etc.;
- Use mountain hill slopes facing different directions for different crops; e.g. using rainfall and temperature variability strategically. They will have plots facing different directions in different catchments, so as to spread risk;
- Areas close to the homestead are more fertile and used as home gardens, for higher value crops like vegetables and coffee, important risk/famine avoiding crops like enset;
- In Madagascar land use is distinctly related to its capability to produce and to water availability. The landscape has three types of land: (i) *bas fonts* (rice valley land); (ii) *tanet* (land adjacent but upland from the rice) which grows some cereal and root crops; and (iii) the upland which is basically unsuitable for cultivation so is used for tree planting or grazing and is often burned to bring nutrients into the rice;
- Luvocs, which are small valleys or gullies (Madagascar), are special niches or drainage ways where water is more plentiful and can be used fruit and vegetable production. The amount of rice valley land and the type of water available (e.g. rainfed, perennial or season stream fed, etc) basically determines the overall well being of the area – the larger the area and the more stable the water supply the better the well being.

A large diversity of crops are grown in highland regions compared to other ecologies, given its rich micro-ecosystems that can provide sources of resistance and diversity. Farmers in highland regions often leave wild varieties in their farms, encouraging cross-fertilization for new potential varieties. (Fleury 1999). "It is estimated that it takes only three to five centuries for a new center of diversification to come into being." More than sixty different types of East African highland bananas are endemic to the Great Lakes Region of East Africa, after having been transported from India more than 1500 years ago. As a result, this diversification of banana varieties from exotic to endemic has made Uganda, Western Kenya and the Kagera region of Tanzania the world's second epicenter of banana production (Karamura et al 2003). Other crops with some indigenous genotypes to the highlands of ECA include duram wheat, highland sorghums, finger millet, niger seed (noug), teff, oats, coffee, enset, and beans, as a secondary center of diversity. People living in temperate climates owe a debt to those who live in tropical highlands (Fleury 1999).

ECA mountain ecosystems are very diverse supporting a wide array of natural flora and fauna biodiversity which is threatened due to population encroaching from adjacent agricultural areas, corrupt governments and poor controls on over-harvesting and exploitation of forests, and the subsequent consequences of poor NRM. However, tiny pockets of natural biodiversity still exist. One such example is Bwindi Impenetrable Forest where there are more than 214 different species of forest birds out of 336 in total. Bwindi exemplifies and represents the natural biodiversity that was once in ECA highlands. Unless sustainable integrated natural resource management can be achieved, these last pockets of natural biodiversity are threatened with extinction. Other important conservation areas and sources of biodiversity include: Semliki Reserve, Rwenzories National Park, forested areas on top of

Mt Elgon, Mt Kenya, Mt Meru, Mt Kilimanjaro, the Ruwengires, the Usambaras and other parts of the Eastern Arc Mountain chain, and Ulugurus.

The ECA highlands are composed of unique diverse ecosystems to which populations have adapted their farming systems. As a result, the livelihood vulnerabilities, strategies and needs differ. These regions arguably harbour the greatest density of biodiversity worldwide. Agricultural systems have shaped the regions biodiversity significantly, though some changes have consequently endangered the natural biodiversity. A mere fraction of the natural forests remain. The presence of valuable genetic resources have been utilised by farmers as livelihood strategies against pests and diseases. They also have natural 'water towers' supplying vast areas including the lowlands. However, livelihoods are threatened by the continued decline of productivity in the natural resource base due to unsustainable agricultural production. The diverse local realities in highland regions including their unique characteristics need to be taken into account in order for positive change to occur.

2.4 Poverty and Hunger Hotspots

According to the Centre for International Earth Science Information Network (CIESIN), based upon their assessment for the Hunger Task Force of the UN Millennium Development Goals program, there are eight major hunger and poverty Hot Spots in Africa. Of the eight, four are located within the ECA highland regions, namely: the Ethiopian highlands, southwestern Uganda, Rwanda and Burundi, certain regions of Tanzania as well as Madagascar. However, in addition to these large generalized areas, there are many other regions that also fall into the same distinction of being a poverty or hunger hotspot. Substantial evidence demonstrates that poverty and hunger occur in tandem, each increasing the other. Moreover, these hunger and poverty hotspots are also the regions of ECA possessing the highest population densities.

ECA regional poverty hot spots are located in different farming systems possessing diverse constraints, geo-political backgrounds and histories. More than 16 million children suffering from malnutrition live in five different farming systems in ECA: the cereal/root crop based, maize mixed (Tanzania), highland temperate mixed farming (Ethiopia), agro-pastoral sorghum/millet based and the root-crop based. Regions with the highest population densities correspond with high densities of child malnutrition – hence, the highlands (IAC 2004). The Ethiopian highland region is characterized by highland temperate mixed farming systems where risks of early and late frosts at high altitudes can severely reduce yields. Moreover, only one annual harvest and a prolonged dry season increases livelihood vulnerability. In Burundi, Rwanda and in the southwestern Ugandan highlands, farmers are able to grow more diversified perennial and annual crops, such as banana, plantain, sweet potato, beans, coffee and cereals but with limited livestock. Usually, they have 2 harvests annually; however, population pressure and decreasing landholding sizes is severe; more than 50% have less than 0.5ha. In Tanzania, the majority uses a mixed maize system. Like Ethiopia, livestock are used more extensively than in highland perennial systems. Vulnerabilities include drought, market volatility and socio-economic differentiation due to migration. In Madagascar, a rice system dominates and is augmented by some coffee production, but mainly cassava, legumes, and maize. Population pressure and decreasing landholding sizes are major threats to production and livelihoods in this system. Risk is heightened by climatically driven uncertainties, armed conflicts or other crises, poor storage, limited infrastructure, and imperfect markets.

The World Bank established their poverty identification level at a daily income of 1$ US dollar /day. Current evidence however clearly demonstrates that poverty cannot be measured simply with a single universal equivalent. AHI, through participatory methods, consulted farmer's perspectives on resource endowment indicators and their own economic conditions, integrating the value of farmer's input in identifying constraints to prosperity, such as farm size (few and less diversified), income sources (few and less diversified); labour (limited and work for others); less access to healthcare and education; few cash crops and fewer livestock; unable to purchase inputs, few wood / fuel sources and amounts, and smaller poorly constructed houses.

The socio-cultural context plays a major determinant in agricultural development by creating a web of interrelationships that interacts with ability to engage and to what extent. For example, a woman as a single mother suffering HIV/AIDS will not be able to take care of the sick within her own household due to her own condition. Since she cannot care for the sick, increased risk of illness amongst her children ensues. Moreover, her own labour input into the farm is nullified due to her HIV/AIDS condition. This compounds when her children are forced to provide the labour necessary to grow enough crops for the family to eat. They will thus not likely have a chance to attend school and acquire an education. Production will decline and malnutrition will further degrade the situation. Coupled with this will be the limited transfer of knowledge from mother to child due to her illness, rendering the children less knowledgeable in farm management. A husbands 'right' to drink and at his whim engage in extra-marital affairs might have been the catalyst. Gender relations have multiple impacts and each in turn has implications. Social issues must be confronted, and those dealing with these in action research for development must be prepared to wade through the quagmire. This is a strong rationale for using an INRM approach to improve livelihoods and environment because non-integrated and non-holistic approaches to social problems rarely produce positive results (AHI 1998).

3. Evaluation of Past Research

The ASARECA NRM Strategy thoroughly reviews past research conducted for NRM (Hatibu et al 2004). AHI is targeting integrated approach and methods development to tackle the conundrum of technical, socio-cultural, policy, economic and institutional constraints. AHI has reasoned that limited adoption of technologies is by and large due to a variety of reasons. Therefore, concentration on approach development and current research methodologies and mind sets are reviewed here.

3.1 Reasons for Limited Adoption of NRM technologies and practices

Although various independent research efforts have generated technologies to improve soil fertility and conservation, there has been limited adoption and impact. Reasons listed here have led to the development of an alternative more integrated NRM approach that is meant to correct for these deficiencies, even though factor research is still required in gap areas:

Limited use of a more holistic, systems approach that integrates biophysical and socio-economic concerns:

- Failure to integrate conservation and other NRM technologies with each other and with solutions to farm and livestock production related constraints.
- The "reductionist" R&D approach has failed to integrate biophysical and socio-economic concerns;
- There is limited understanding of the 'whole picture' given the technological mindset. Important areas are left 'unattended' such as: local collective management arrangements, customary resource management, local power and gender relationships, government versus traditional rules, among others, that consequently affect NRM;
- Limited recognition of trade-offs inherent in applying NRM solutions: long term versus short term; costs and benefits to various stakeholders; collective versus individual gains; among others;
- Limited attention to scales and levels of decision making, with most concentration of plot scale and farmer level, and limited on farm systems, watersheds, etc. and non-inclusion of other stakeholders, such as community interest groups, district and national governments, etc.

Factoring in of important externalities early on has been ignored:

- Lack of market, credit and input supplies act as disincentives for farmers to take up new technologies. Short-term needs but long-term payoffs have not encouraged farmers to adopt;

- Failure to take account of policy issues related to definition and enforcement of local by-laws, communal management and public investments;
- Limited attention to scaling up barriers and institutional arrangements;
- Limited use of an 'innovation systems' approach which recognizes that there are a number of actors and factors involved that need facilitating so as to optimally contribute towards solving a problem or addressing an opportunity.

Technology development process has not encouraged adaptation and innovation by users:

- Researchers are seen as the main 'innovators' which limits use of indigenous knowledge, that occur as part of an innovation 'process' which is not linear nor set;
- Limited training / knowledge of extension workers in the nuances of application and adaptation NRM technologies has resulted in limited adoption;
- NRM technologies are knowledge intensive. They require management decisions based upon site and socio-economic circumstances for adaptation and application;
- Limited use of participatory research methods that include building of farmers' own experimental and adaptive capacity limits development and application;
- For the most part, technologies have been developed by researchers alone with limited input from farmers, so do not fit farmers' circumstances;

3.2 Past Approaches and Limitations

Approaches to research over the last twenty years have focused heavily on technical solutions related to production. Each commodity and its production issues (pests and diseases, agronomy, NRM, etc.) are also handled separately. NRM has been handled as a separate section in research systems so there has been limited integration even of NRM components. This is often referred to as a 'reductionist' approach or method which has resulted in 'reductionist' thinking, and is seen as an 'accurate' way to apply the scientific method to agricultural production issues rather than being impact oriented.

On NRM issues, more research has been done on soil fertility issues (on plots) than conservation, which has typically been handled as a development issue by extension services. Economics is yet in another section though rarely integrated and has very limited personnel. With farming systems research (FSR), there was the inclusion of an economic perspective; yet, it was still obvious that many other components and their interactions had not been identified or worked upon. The systems perspective came into FSR diagnostics but most research was reduced to components that were checked for feasibility within the systems context. Sociologists and anthropologists in the NARIs are non-existent and in IARCs, extremely few.

Most research has been conducted on the research station and/or under the control of researchers on farmers' fields using small experimental, replicated plots to control variation and non-experimental variables. Although scientific, these research procedures were not able to capture multiple variables, systems factors and adaptations needed by farmers to make them work, nor were they useful to explore larger scale landscape issues, temporal factors or social aspects required in NRM. Research techniques were also not adequate to work with more 'messy' human and institutional factors. Social problems require a social component in solutions. Modeling and GIS came in, but lacked participatory elements so results were often academic or inaccurate. Participatory research brought in an important philosophy that has slowly been adopted and institutionalized, though still with skepticism as it was felt to lack scientific rigor. Results, even though less 'scientific,' are producing greater impact and influencing research and this success has kept it from dying out. Action research is now being adapted from NGOs and other sectors (health and education) that have been using it to address issues that are highly context specific and are affected by sociological and institutional factors. (see section on INRM for its application in R4D). Though spoken of in the past tense, this adhesion to traditionally scientific models in research continues to exist in many institutions.

Research and development have, by-and-large, been separate activities conducted by separate actors. Research has typically been setting priorities without wide consultation, although this is changing, mainly bringing in farmers but not yet the private sector or development supporters, strategy shapers and policy makers. The new research for development (R4D) thrust has come up in the last 1-2 years. There has been very limited work on social, economic and policy dimensions that are major constraining factors inherent in development and NRM problems. Basically, R&D actors have not been able to provide an integrated front to solve land degradation and related poverty issues.

Limited success has precipitated renewed analysis of the situation and testing on pilot scales of various community-based NRM approaches mainly by development projects. Research has had little input into these and impact is anecdotal but promising. Approach development for both research and development has made considerable strides conceptually, but has had less success in uptake and application by NARIs and IARCs (reasons discussed below).[3]

There has been considerable work by agricultural research, development and conservation organizations around the world on approaches, methods and tools that are aimed at improving the effectiveness and outcomes of improved NRM from the perspectives of the managers themselves, as well as those that are providing services and information on NRM. Four main approach and method areas that have each added value include: (i) those that enhance user participation in the technology generation and promote better NRM at farm and landscape scales, such as participatory technology development, community-based NRM, integrated watershed management, etc; (ii) those that include the livelihood concepts including human, social and other assets, risks and vulnerability factors; (iii) those that recognize hierarchies and levels that are interlinked and integrated (plots, farms, watersheds) such as the agro-ecosystem management approach; and (iv) those that recognize and incorporate diversity in the stakeholders themselves and their stakes such as in gender and multiple stakeholder analyses (Stroud and Khandelwal 2003).

Tools have been developed aimed at improving participation and awareness building; bio-economic models that help researchers to understand systems and management trade-offs; geographic information systems that improve spatial understanding; means to influence policy makers and decision makers, among others. The new approach "Integrated Natural Resources Management" (INRM) incorporates these 4 main areas: sustainably building and optimizing social, physical, human, natural and financial assets; participation of stakeholders having a 'stake' in the resources, their activities in this respect, and their relationships linking across various scales (farm-landscape-watershed) and levels of decision making (households-community-district-national) depending upon commonly agreed need-based issues; values and incorporates perspectives and expertise from various quarters, e.g. research disciplines, government decision makers, community members and leadership, and from the development actors including extension, NGOs, and CBOs. INRM promotes research for development (Campbell et al, in press).

Recently, it has become more evident to many R&D practitioners that resource management strategies result from interaction between social, cultural, historic, economic and physical elements. Social, cultural and historic elements include institutions, governance, power relationships, information access and accuracy, both on macro and micro levels, especially where natural resources managers exist, all within a diachronic context. History plays a tremendous role in the 'hardness' of existing socio-cultural elements. Thus, the Integrated Natural Resources Management (INRM) approach is now being developed and tested by AHI, other IARCs and partners around the world (see subsequent section). This approach, which evolved from earlier approaches, was largely borne out of analysis, practical need, and desire to make an impact on NRM where it had not been possible before. The

[3] For a full review of approaches refer to: Stroud A and R Khandelwal, 2004, In Search of Substance: 'State of the Art' of Approaches, Strategies and Methods for Improving Natural Resource Management and Livelihoods: Indications for Future Directions, AHI, Kampala, Uganda

INRM approach has many similar characteristics to the more generic IAR4D approach that is also under development.

3.3 Reasons for Research's Failure to Use Alternative Approaches

Regardless of all of the various approaches developed to improve R&D impact, there has been limited uptake and institutionalization in research organizations for various reasons:

Science tradition and organizational culture:

- Barriers of acceptance of new approaches by more conventionally trained researchers who were used to a reductionist approach;
- Skepticism on science in participatory methods due to professional traditions and biases;
- Organizational culture and relatively top-down management styles may limit partnerships;
- Largely ignoring inputs from TEK because seeing as 'non-scientific.'

Capacity deficits and limited attention to 'experiential learning':

- Approaches had good philosophical underpinnings but methods and 'know-how' lagged behind;
- Difficulty in understanding and applying new concepts and tools;
- Limited use of organized experiential learning and systematic reflection;
- Limited involvement of a broader range of disciplines, e.g. social scientists, economists, systems modelers, ecologists, etc.;
- Those using approaches often remained in project-funded enclaves and were not fully integrated.

Non-supportive organizational management and structure:

- Limited or over-concentration on mandates which limited ability to take a more holistic approach towards finding solutions;
- Lack of a strategy with support and expertise to move from small, modular pilot teams to wide use of the approach within organizations;
- Implementation problems due to monitoring and reward structures do not favor integrated team work;
- Limited resources to move out to farmers and hold stakeholder consultations frequently enough;
- The way in which research organizations are structured along commodity/factor lines limits team work and prevents integration;
- Limited empowerment from management to make and sustain partnerships;
- Separation of research, training and extension into different organizations makes necessary linkages more problematic, limits experiential learning and limits managers/trainers time in the field where closer to development (or lack of) outcomes.

Therefore, new ways of generating and adapting NRM innovations and new modes of knowledge sharing are needed (section 3.4). Concentration on technology components needs to be done in an *innovation systems* context where multiple sources of innovation are facilitated and more concentrated research effort is required on generating NRM principles, that is, understanding the context and circumstances where NRM interventions can work best and trade-offs that need to be considered. Farmer experimentation using these principles can help them to apply NRM interventions to site and client specific situations. Greater consideration by researchers of systems and landscapes management perspectives and action should be enhanced in the research and development work. (Stroud 2002)

3.4 Deficits in current knowledge management systems limits impact

Current deficits of KMS and impacts on various stakeholders of limited knowledge management and learning culture are provided in these examples:

- Policy and decision-makers lack the required knowledge necessary in understanding the complex socio-cultural, political, economic and environmental problems of natural resource degradation, its causes and methods of reversing these trends; they cannot be apart of the remedial process.
- Without adequate knowledge of NRM, policy and decision-makers can easily forge policies and make decisions that have further detrimental effects upon the natural resource base.
- Researchers and research institutions have limited access, understanding and therefore limited use of 'local agro-ecological knowledge' or 'traditional ecological knowledge.' This results in 'expert' perspectives and 'top-down' approaches which limits innovation, facilitating the erosion of the former knowledge system, which contributes to poor NRM.
- Extension actors need adequate knowledge regarding the technological innovations coming from research, current policy and political institutions, as well as an appreciation and understanding of stakeholders knowledge of NRM, socio-cultural structures and relationships.
- Connected to the 'top down' reductionist approach used by most 'experts' is that stakeholders have been seen in the past as powerless actors bereft of equitable knowledge to scientific research and thus sidelined from the technology implementation; so stakeholders remain marginalized in the NRM R&D process at the start.
- Farmers can rarely access valuable research findings, market information and the like. As a result, uptake and adoption rates in the past have been poor.
- Stakeholders possess vast knowledge of NRM and that knowledge plays a key role in identifying the most effective methods of implementing NRM technologies; hence the development and necessity of participatory methods. Knowledge sharing between all parties serves to enhance the positive impact potential of technology implementation initiatives (Ritho 2003).

In summary, agricultural research has been conducted using a reductionist approach, making it difficult to work with the complexity of NRM, and limiting progress towards solving NRM issues. Moreover, expertise and funding to NRM has been limiting. Institutions are not organized to promote integrated research. Traditional science has resulted in 'top-down' expert-initiated experimentation with little participation from stakeholders. Other factors limiting success in tackling NRM issues is limited work on weak policy structures, limited incorporation of stakeholders' knowledge and input, failure to address socio-economic and cultural issues linked to NRM, and the fact that NRM innovations are labour and time intensive, leading to farmer's reluctance to adopt.

Solutions to 'failed' past NRM approaches are affected by inadequate inclusion of social sciences, institutional learning and change (ILAC), and tackling the human causality factor. This has resulted in demand for increased participation from stakeholders in research, development, implementation, monitoring and governance, from national to local levels, and in the appreciation of TEK and its fundamental role in NRM. Capacity building within research and extension institutions and of development and government partners is required along with improved communication and knowledge sharing between all actors. There is need to adopt a holistic systems approach to augment classical reductionism currently used that is manifested in the concept of Integrated Natural Resource Management (INRM) which AHI is currently developing and operationalizing.

4. Constraints and Opportunity Analysis

4.1 Economic and Production Issues

4.1.1 Food and Income Shortages resulting from Production Constraints

Some factors reducing production are directly linked to the natural resource base while many others are human and socially induced. Many constraints emerge from combination of these three. However,

there are many interlinked factors that negatively impact production, further justifying an integrated approach to NRM. Separately, these factors include:

a) Natural resource based constraints[4]:

- Soil erosion from natural causes
- Decreasing soil organic matter content
- Poor water infiltration rates and increased water run-off
- Absence of organic matter and manure
- Ecological shifts, for example, decreasing biodiversity in vegetative cover
- Infestation of pests and diseases
- Climatic changes (periodic water shortages or floods)

b) Human induced production constraints:

- Continuous cultivation of steep slopes or leaving highly erosive soils bare at the onset of heavy rains leading to erosion
- Continuous grazing of livestock
- Continuous cropping without rotation, particularly of cereals
- Non-replacement of trees used for fuel and building materials
- Bush and grass burning
- Poor nutrient recycling and limited transfer of nutrients from nutrient rich to poor areas and limited use of legumes to improve nutrient balance and soil cover
- Decreased use of fallows
- Poor animal husbandry
- Undermining or limited upkeep of soil conservation structures
- Tree planting practices or species which limit undergrowth and soil cover
- Pathways that create water runways or channels and increase erosion
- Over harvesting of natural products without replenishment

c) Socially and institutionally induced production constraints:

- Progressive land fragmentation (ancestral traditions) of family holdings and a continuous multiplicity of complicated land-use systems
- Low levels of soil conservation technologies, compost making and application, etc (knowledge)
- Loss of or under-valuation of traditional knowledge and norms / practices
- High costs of land and labour
- Transportation constraints (transporting manure to distant plots)
- Land and tree tenure insecurity (policy and infrastructure)
- Poor dissemination of information approaches which are often non-participatory
- Unequal gender relations (for example: drunk men and overburdened women)
- Various types of conflicts with limited reconciliation mechanisms: grazing, land use, theft, boundary
- Break down or weak collective action and application of by-laws
- HIV/AIDS, malaria, and other diseases (decrease in labour from sickness and death)
- Religious holidays and beliefs that interfere with farm work
- Government rules and regulations contradict traditional mechanisms

4.1.2 Input and Output Market and Credit Constraints

- Lack of public investment in roads, railways and telecommunications;
- Lack of marketing information which raises transaction costs while searching for buyers and sellers, enforcing contracts and resulting in lower bargaining power;

[4] NR induced constraint include those related to: soils and soil fertility, water, biodiversity and livestock

- Limited storage capacity resulting in inability to speculate on the market;
- Long-term investment by private traders in transport and/or storage;
- Poor formal financing and pricing mechanisms – prices fluctuate dramatically resulting is more risky, personalized, cash-based agricultural trade
- Lack of grades and standards for quality;
- Low level market transparency;
- Frail legal environments governing property rights and contract enforcement.
- Local markets are often glutted just after harvest so prices are low. Low local prices and wage rates limit buying power. (Gabre-Madhin, 2001; Hatibu et al 2004)

Some of the economic opportunities available for mountain areas are:

- Niche markets of specialized commodities given unique growing conditions, agro-ecologies and biodiversity potential. This would lead to further exploitation of high value market products, such as herbs, medicinals, vegetables, fruits, teas, plants having cosmetic value
- Staggering commodity supplies to markets given varying rainfall and growing patterns
- Better water management and intensification of niches so as to optimize or extend seasons
- Develop businesses in ecotourism and spiritual spots
- Enhance organic marketing and production techniques to increase returns to commodities
- Sale/payments for environmental services (ES) (carbon and water credit systems)
- Improved productivity with better NRM resulting in higher yields and lower pests / diseases

In summary, farmers face challenges such as: inadequate access to markets, yield deficits, lack of and access to market information (e.g. current product prices), low value products and limited possibility to add value, inadequate resources to buy farm inputs and simple labour-saving tools, limited local supply of inputs, inadequate public investment in transportation and telecommunications and limited investment from the private sector, risky personalized cash-based transactions, limited storage capacity, lack of or inadequate access to credit, volatile fluctuation in prices, lack of quality grading and standardization, and inadequate legal enforcement protecting farmer's rights. These constraints force farmers to adopt livelihood strategies that compound the degradation of the natural resource base. It is hypothesized that more income would mean greater investments into NRM. However, experience shows that this is not usually the case. Thus, the danger is that improved production levels will increase the mining of natural resources, resulting in short term gains but negative effects for long-term sustainability. Therefore, there must be mitigation or incentive strategies put into place to ensure sustainability.

4.2 Social Welfare

4.2.1 Education and development of human capital

The rural poor are affected by poor education, which exacerbates their position as rural poor and limits their options to rise out of poverty. Highland areas tend to be less accessible thus more limited in terms of social services. Women, in particular, are affected by limited education opportunities resulting in high illiteracy rates (see gender issues). This negatively influences participation in collective action, groups and other development activities. Several perspectives argue that education is the primary capacity tool necessary for sustainable development. Literacy rates for women in highland areas are extremely low. Rural areas have seen inadequate development of schools required to accommodate the population. In the ECA highlands, high population densities aggravate the problem. Another major problem is a lack of enough qualified teachers coupled with low wages forcing teachers

to turn to other sources of livelihood income. School fees remain relatively high for rural households meaning that not all families can send their children to school. In addition, school curricula in operating schools and classes are not pertinent to local livelihoods as they are based on developed country models. Therefore, children's education has become secondary to farming and grazing. Furthermore, poverty stricken farmers (the majority being female headed households) simply do not have enough labour necessary to achieve all necessary livelihood strategies, so children play an essential role in domestic and production activities. Some use livelihood strategies that keep children, particularly girls, away from school, even when resources permit. Locally pertinent curricula properly functioning and accessible to all would permit the transmission of knowledge to children, thus enhancing capacity for future INRM.

Prospective solutions to solving education issues include: (these solutions are generic, not only particular to ECA highlands)

- Enhanced policy at national and local levels permitting the creation of locally derived curriculums pertinent to livelihood needs in highland areas – in this case, integrated NRM;
- Alternative forms of tuition payment (crop exchange, labour service);
- Extra-curricular activities including community on-farm labour service, teaching children differing strategies and their subsequent impacts while filling in a labour gap (knowledge sharing and transmission enhanced).
- Detailed courses on biodiversity elements, their importance, role and characteristics;
- Programs developed teaching traditional ecological knowledge (TEK);
- Tree planting activities governed by both schools and local authorities;
- Government's facilitation in providing school materials (pens, paper, etc);
- Educational activities (drama, sports, music, etc) thematically tackling awareness of NRM issues;
- Strengthening teacher training programs and enrollment;
- Solidifying policy (both local and national) orientated mechanisms of supporting teacher's livelihoods to ensure continued education.

These solutions would help provide a long-term solution to NRM. Education remains a fundamental key to insuring proper NRM from local actors, thereby achieving sustainable agricultural production, creating specialized scholars versed in both scientific and TEK approaches resulting in a future generation with capacity through their knowledge of all INRM issues to ensure that external development forces are no longer required.

4.2.2 HIV/AIDS Impact Upon Agricultural Production in the Highlands

UNAIDS estimated in 2002 that 28.5 million adults and children were living with HIV/AIDS in Africa. In 2001, 2.2 million died alone from the epidemic, surpassing any other cause of death continent-wide. In sub-Saharan Africa, the average life expectancy for those afflicted by the virus drops to 20-25 years, sometimes even below this for children. Evidence now suggests that HIV/AIDS is having a disproportionately high impact in agrarian sectors. The HIV/AIDS epidemic must be understood holistically and the impacts it produces analyzed thoroughly in any INRM approach to action-oriented R&D within the ECA highland regions, where there is a high population density that is sure to be affected (UNAIDS, 2002 in Waal and Tumushabe 2003).

In the agricultural sector, people are less capable of absorbing the negative impacts derived from human resource loss due to HIV/AIDS. The highland regions are particularly affected given the population density which influences whole countries given they produce over 50% of their respective countries agricultural production. HIV/AIDS intensifies labour shortages, increases malnutrition, becomes a barrier to traditional mechanisms of support during calamity, and puts incredible stress on rural women, already struggling under patriarchal societies that still cling tenaciously to inequitable gender rights. Examples of such are division of labour, land and resource rights and access and intensifying macro-economic crises due to agricultural export reduction to name a few. Recent surveys

in the Kenyan highlands have produced evidence of how the cost of HIV treatment puts families back into the poverty trap with permanent loss of land, livestock and other key assets (Russell et al 2003).

R&D models for income generation, food security and NRM require a dramatic revision based upon the changing dynamics in agrarian societies due to the impact of HIV/AIDS. The basic assumptions built into economic and development analysis, farming systems research, livelihoods studies, and coping strategies research, e.g. that a household can command basic food entitlements in 'normal' times, should be questioned. Equilibrium models in economics, demography and other branches of social and economic science, may no longer be valid.

4.2.3 Gender Inequity

Gender inequity impacts agricultural production from macro to micro levels. Women play a vital role in production activities in all farming systems in ECA at local levels. Men usually control the assets (land, trees, livestock) and make decisions in this regard. As a consequence, gender relations have fundamental impacts upon NRM and subsequently, degradation. Most highland areas are characterized by patriarchal social structures where men collectively (through a socio-historic process) have formed the boundaries of women's roles in reproduction and production. Moreover, due to these governing structures, women have found themselves marginalized especially regarding equal rights to resource access and use and in decision making at household, community and higher levels (Kigankomo 2002).

Over the last forty years, women have had to face an increase in demands upon their time and labour. With changing labour structures and livelihood strategies for men caused by macro and micro dynamics have resulted in a drain of labour force of men to urban centres, rising levels of alcoholism, laziness, the impact of HIV/AIDS and other illnesses and perhaps most importantly, the perception by many men that married women have found themselves to be responsible for not only the tasks of reproduction, but to a larger extent production. Current trends in the highlands demonstrate that female-headed households (for example, 33-51% in Kabale Uganda) are increasing.

Demands upon women's time are forcing them to adopt new strategies for coping against livelihood threats. Often, this results in strategic selection of tasks that are reprioritized in favor of others. Marginalized women suffer from extreme time stress loads, reducing their physical and mental health, causing poor nutrition, increased illness (which further draws labour away from farming) and thus the capacity of the farm to produce for the family. Moreover, such stressed women can barely afford to integrate labour intensive practices in NRM.

Participation in R&D groups by women has been relatively high. Women tend to stay engaged for longer periods and are more responsible in managing group assets than men (Sanginga and Stroud 2001; CEED 2004). This is encouraging; however, some situations limit the participation of women – illiteracy, limited assets so that the contributions groups demand cannot be met, and the time factor mentioned above. Women tend to contribute less in mixed groups, given cultural norms and gender power relations. There are relatively few women involved in R&D services or local government, thus, female-to-female links and outlets are few. Some specific issues concerning women cannot be discussed with men, and in some cultures, male R&D workers are not allowed to talk to women. Specific strategies are needed to overcome these difficulties.

R&D strategies need to be re-evaluated given these challenges. Currently, emphasis is being given to propelling economic growth, but ultimately, there are no 'silver bullets' and a more holistic approach needs to be taken to include social parameters. Within a better R&D framework, methods and strategies are needed to improve inclusion and to truly engage poor people, women, youth and other marginalized categories in R&D. Although often left to the NGO sector, it is extremely important that public sector R&D organizations wholeheartedly take on poverty, gender and HIV dimensions by developing explicit strategies and options. This includes integration of local capacity building into research work, tackling issues that are important to diverse groups of farmers, and finding solutions that will suite those that are disenfranchised. Research can contribute towards understanding the

dynamics, sorting out the social quagmire, providing more holistic development strategies and policies, and by introducing better monitoring systems. Research must pay more attention to social differences, gender and power relations, nutrition and food security and other livelihood dimensions, and work on methods, approaches and strategies that can better address and work in differentiated socio-cultural contexts.

4.3 Policy Issues

The impact of policy on NRM sustainability cannot be underestimated nor sidelined and is entwined with developing social capital. Successful decentralization led by government needs to be coupled to true devolution of power and decision making, empowerment to take on responsibilities, and capacity and funds to do the work. The result of traditional policy erosion leading to fragile social capital manifests in mistrust, individualism in collective issues, refusal or inability to invest in NRM, and continuing degradation of the natural resource base culminating in lower production. Policy development and proper implementation best occurs through dialogue at all levels, from government to local authorities, and within research and extension institutions, and between government and resource users and dialogue is weak.

More than 10 million people are displaced due to a myriad of reasons including war and conflict, natural disasters, the construction of hydroelectric dams, desertification and more. Eastern Africa is no exception; high population density areas such (Rwanda, SW Uganda, W Tanzania, E DRC) have faced population displacement due to war (civil and international), genocide, political instability, food insecurity and discrimination. Secondary effects from refugee camps harm the environment and increase vulnerability of those affected. Political instability and insecurity negatively affect collective action and social capital, and it can take years to recover. Governments need to work towards creating good will, build their own social capital and international collective action, otherwise conflict will continue.

Issues involving policy include land tenure, ownership and access to communal natural resources as well as providing direct and indirect incentives to care for or invest in NRM, as well as protect NRM rights. Policy has to operate at different levels - trans-boundary (between nations) to between neighbors. Conflict, corruption and theft are a result of poor governance, limited monitoring, and limited involvement of local people in formulation and application of policies. International treaties and policies can be created without consideration or consultation of local realities while traditional governance may not be valued and therefore has eroded.

Governmental policy must address markets, market information, supply of farm inputs, and other associated economic issues facilitating stakeholders' livelihood strategies. Development investments can strengthen infrastructure and communications improving access to input and output markets. Research institutions and extension need support to research, implement, and monitor policy and related issues by using participatory methods and promotion of inter-institutional knowledge sharing at various levels. Unless the complex of policy issues are dealt with accordingly, INRM innovations will continue to face poor adoption rates. AHI has some experience in facilitating participatory policy formulation and implementation using action research, which can help bridge decision-makers with stakeholders, subtly enhancing capacity (understanding livelihood challenges as well as rights, rules and social obligations) while mediating conflict.

The following are the fundamental NRM concerns in ECA requiring collective action and conflict resolution include:

- Cross-border issues such as soil and water management between highlanders and lowlanders, illegal logging, conflicts over water, land and mineral rights between nations and ethnic groups, trade agreements affecting the marketing of NR products, transfer of livestock and crop diseases;
- Disagreements between stakeholders with different interests and livelihoods (those protecting forests and those deriving livelihoods from the same resource base, conflicts between pastoralists and cultivators);

- Between neighbors over management of water and soil, theft of water or other assets, arguments over land access rights, and conflicts over livestock grazing crops;
- The illegal removal of NR products and implementation of unsustainable bio-prospecting.

Among the generic incentives and good practices requiring assessment on their adaptability to local situations are:

- Development of eco-environment incentives (eco-labeling and product certification, improvement of markets for NR products, determination of property rights, payment for incremental costs of NRM);
- Environmental funds (fees, charges, fiscal incentives, payment for environmental services);
- Social and cultural incentives (acknowledgment of indigenous knowledge, recognition of community intellectual property rights, exclusive rights for communities to exploit NR);
- Policy and legislative frameworks (regulations and access to NR, technology transfer, benefit sharing agreements)
- Assessing the impact of regulations, penalties, and fines that affect the direction of investment (Hatibu et al 2004).

Any initiative tackling the challenge of NRM in highland regions requires a comprehensive emic approach to conflict resolution, consultation, and social capital generation and collective action promoting positive social relationships both horizontally and vertically. Such conflicts require the combined effort of stakeholders, governmental institutions and authorities, research institutions and properly implemented action through well-networked extension.

The following are some of the researchable issues:

Improve vertical information flows to improve decision making at all levels

- Improve information and data for decision-making processes at all levels;
- Regional intervention through institutional collective action (including governmental agencies and authorities), considering regional particularities and socially constructed realities in order to forge stronger vertical linkages in policy consultation and implementation.
- Develop and establish stable networks to improve information flow through all levels of decision-making.
- Facilitate institutional structures and arrangements for the implementation of incentive measures.

Improve tools and instruments for cost sharing and decision making

- Develop tools for mainstreaming NRM into planning and decision-making processes;
- Improve understanding of benefit and cost sharing mechanisms;
- Identify relevant costs and benefits and advice in policy formulation to ensure their fair division among all parties.
- Develop instruments to measure costs and benefits of trade-offs

Improve facilitation methods to build social capital and capacity to participate in policy formulation and implementation

- Identify best practices, approaches and methods that can make a major contribution to handling groups and fostering collective action, particularly to involve women as major NR users.
- Qualitatively assess the socio-cultural, historic, religious/spiritual constructions and structures through which stakeholders perceive their reality, and thus their challenges.
- Build capacity of policy makers on understanding the implications of international conventions on local implementation;
- Develop participatory policy formulation methods at right levels
- Improve negotiations and conflict resolution over cost and benefit-sharing of natural resources.

It is essential that national decision-makers become a part of the process, creating the necessary channels to facilitate local NRM policy creation, development, implementation, governance, information and knowledge sharing. Furthermore, they must also facilitate the possibility of trans-boundary consultation in conflict resolution.

4.4 Institutional Issues

The institutional arrangements and potential impact of research, development and community-based involvement in NRM can be improved. Institutional arrangements need to be reformed to ensure better cooperation and less bureaucracy so as to be able to implement the principles and practices in the INRM approach. A linear TOT model is not working and is being slowly replaced by an innovation systems approach, that is, recognition of the dynamism of innovation and its multiple sources that if managed, can provide faster more relevant results, or new ways of doing things. Improved partnership modalities and networking can be facilitated to avoid costs and old administrative models that hinder knowledge sharing and collaborative action, the innovation system approach can work. Research institutions need to broaden their networks, put aside their mandates, improve their credit sharing and operate 'with one voice,' rather than operating in relatively small and fragmented pilots each promoting a partial solution.

Many institutions require internal change or 'paradigm shifts' to adequately contribute to INRM; for example, to facilitate proper participatory method implementation, information sharing and knowledge management in order to create a 'learning culture.' Institutions must become involved in frequent self-evaluation and reflection, and remove policies and structures that impede their capacity to learn and change. They must improve documentation, analysis and synthesis skills, be able to design and use participatory M&E, and speed up the time it takes to acquire and take up new innovative practices, which currently is slow. NRM demands a broader contribution from disciplines and skills which means that institutions need a plan to build competencies in new areas, such as social sciences, ecology, systems agronomy, facilitation, negotiation, partnership and team management among others.

Community institutions/groups need to improve NRM through facilitated collective action, by promoting more equitable benefits and cost sharing, conflict resolution, monitoring progress, and ensuring their sustainability. Dependency syndromes created by development projects and government handouts hinder collective action which often does not pay cash anything directly. Development and research projects, and NGOs do not necessarily use good practices in building community social capital. Moreover, where local community groups remain weak due to weak social capital and thus collective action, R&D institutions must learn the appropriate tools and methods necessary for strengthening capacity building at local levels.

Too often, access to world wide literature and information and research results is restricted due to insufficient resources, means for its acquisition or a proactive learning culture is lacking in itself. Improved knowledge management and information sharing would result in faster capacity development and greater innovation for improving NRM. Embedded in this, is valuing Traditional Ecological Knowledge (TEK). The local pertinence of TEK cannot be underestimated, so research institutions need to value and appreciates its contribution to NRM.

One of the main issues confronted in institutions is their current use of a reductionist approach as opposed to an integrated, systems approach. This results in technologies that are not being taken up by very many farmers. The socio-cultural and political aspects need to be taken on board, even to solve biophysical problems. This is embodied in the INRM approach that AHI is developing and which addresses a number of the institutional shortcomings through these premises that are backed by methods, new skills and expertise:

- Use and facilitate new models for institutional arrangements and partnerships;
- Explicitly empower and build the capacity of resource managers and users recognizing that change and development require specific adaptations;

- Increase the level of dialogue and deliberation among stakeholders, improving interactions between research and 'clients';
- Incorporate and facilitate social learning processes for community, research entities and others;
- Facilitate trade-off analyses, exchange and negotiation among stakeholders having different stakes / perspectives to resolve conflicting interests and promote benefit sharing;
- Integrate systems and multiple level perspectives through scenario analyses and use of other participatory, analytical tools to improve decision making and selection of options;
- Generate and integrate complementary policy, technological and institutional alternatives that have a direct bearing on the problem or opportunity;
- Empower relevant and diverse stakeholders, applying organizational development and change principles, to strengthen collective and individual decision making, analysis, planning and implementation, lobbying, negotiation and conflict management;
- Recognize and take into account those activities, actors and their relationships link across various scales (farm-landscape-watershed) and levels (households-community-district-national).

5. Conclusion

The current situation in the highlands of the East and Central African ecoregion is challenging. Natural resource base degradation has contributed to poverty and poverty in turn has contributed towards people's inability to stop degradation. Unless immediate strategic actions from those involved in NRM R&D (including stakeholders) begin to reverse this situation, the current situation will become worse.

NRM requires an integrated, systems approach that utilizes the collective body of knowledge, scientific and agro-ecological (TEK), a mixture of social and biophysical science, to find and implement solutions. Policies established by decision-makers in government need to reflect the interests of stakeholders from all levels. R&D organizations need to facilitate local empowerment of self-autonomy and capacity. Knowledge sharing must enhance capacity building in government, research, extension and other stakeholders. Social capital and collective action need to drive change in NRM practice. Education must play a fundamental role and be relevant to the local context and build capacity to manage their environment and improve livelihoods. Gender inequality continues to hamper progress while HIV plagues millions, reducing productive capacity.

The constraints are many and diverse and one finds them interwoven forming a quagmire of biophysical, economic, social, cultural and political threats, hence the necessity for an integrated approach.

6. References

AHI 1997. PRA Reports from Areka and Ginchi, Ethiopia Benchmark Sites,

AHI 1998, PRA Reports from Kabale, Uganda and Kenya and Madagascar Benchmark Sites.

AHI, 1998, Phase 2 Project Proposal, AHI Kampala, Uganda

AHI 2001, Technical Report: End of Phase 1 (1995-97), AHI Kampala, Uganda

AHI, 2001, Annual Report 1998, AHI Kampala, Uganda

AHI 2002, Phase 3 Project Proposal, AHI Kampala, Uganda

AHI 2003, Profile

Alumira J and AO Awiti, 2000, The African Highlands Ecoregion: Situation Analysis, AHI Regional Office, Kampala, Uganda

ASARECA 2004, Natural Resources Management for Agriculture in Eastern and Central Africa 2005 – 2015. Nairobi Kenya, October 2004.

Berkes, F. 1993. "*Traditional Ecological Knowledge in Perspective*." In: Traditional Ecological Knowledge, concepts and cases. IDRC and IPTEK, Ottawa, Ontario.

Campbell B, A Stroud, J Hagmann, and L Wolenberg, (in press), Integrated Natural Resource Management in Practice, CIFOR, Indonesia.

CEED 2004, Managing Change – Farmer Institutional Development under NAADS, A Field Study on Farmer Institutions working with NAADS, AHI Kampala, Uganda

David, S., 2003, Poverty and Rural Livelihoods in Selected Sites in Uganda, Malawi and Tanzania, CIAT Occasional publication series no. 41.

Fleury, J.M. 1999, Mountain Biodiversity at Risk: Threats to Knowledge from High Places. IDRC Briefing No. 2, September 1999.

Gabre-Madhin, E. 2001. Market institutions, transactions costs, and social capital in the Ethiopian grain market. Research Report 124. International Food Policy Research Institute, Washington, DC. In: Agricultural Development Policy in Eastern and Central Africa: Strategic Investment Priorities for Growth and Poverty Reduction. A report prepared under the ASARECA/IFPRI Project *Strategies and Priorities for Sub-Regional Agricultural Development and Sub-Regional Agricultural Research-for-Development in Eastern and Central Africa, 2004.*

Gichuki, F.N. 2002, Sustainable Mountain Area Development in Africa: Responding to the Challenges.

Hatibu, N, A Stroud, D Nyamai, A Demessie, J Ndikumana, H Elliott, 2004, ASARECA NRM Networks and Programs Strategy, ASARECA Secretariat, Entebbe Uganda.

Hoekstra D.A, 1988. Summary of zonal agroforestry potentials and research across land-use systems in the highlands of eastern and central Africa. AFRENA report No. 15. ICRAF. Nairobi.

Howard, P.C. 1991, Nature Conservation in Uganda's Tropical Forest Reserves, IUCN Conservation Library.

Interagency Agricultural Council 2004. Realizing the promise and potential of African agriculture.

Ingold, T. 1987. The Appropriation of Nature: Essays on Human Ecology University of Iowa Press, Iowa.

Jabbar, M.A., Ayele G., Atnafe Y., Dubale P., Tefera B. 2000. Nature and Causes for Land Degradation in the Oromiya Region: A review of Literature. In: Jabbar M.A., Pender J., Ehui S. Policies for Sustainable Land Management in the Highlands of Ethiopia. Summary of papers and proceedings at a workshop held at ILRI in Addis Ababa, May 22-23, 2000.

Johannes, R.E. 1993. "*Integrating Traditional Ecological Knowledge and Management with Environmental Impact Assessment*." In Traditional Ecological Knowledge, concepts and cases. IDRC and IPTEK, Ottawa, Ontario.

Karamura E., Karamura D., Sharrock S. 2003. Conservation through Utilisation of Banana and Plantains in the Great Lakes Region of East Africa: Final Report, INIBAP-ESA, Kampala, Uganda.

Kigankomo, M. Marietha Z. Owenya,[1] Charles Lyamchai[1] 2002. The Influence of Traditions and Customs on Gender and Quality of Life in Mountain Areas: The Kilimanjaro Experience. International Year of the Mountains, Africa Conference. UNEP, May 2002.

Mailhot, J. 1993. Le savoir écologique traditionnelle. La variabilité des systèmes de connaissance et leur étude. Montréal, Bureau de soutien de l'examen public du projet Grande Baleine, Dossier Sythèse No 4.

Notenbaert, A, 2004, AHI Zone Map, ILRI (Data sources: (i) POPDEN2000 raster with Population Density in the year 2000 (number/km2) CIESEN, 2004, GPW III Beta http://beta.sedac.ciesin.columbia.edu/gpw/download.html; (ii) ANN_RAINFALL Raster with annual rainfall figures. Source: WORLDCLIM Version 1.2 http://biogeo.berkeley.edu/worldclim/worldclim.htm WORLDCLIM is a set of global climate layers (grids) on a square kilometer grid. This database is currently under development. The last version released (March 2004) is Version 1.2. There is a small number of "known issues", please read these, and report additional problems you might find. The data layers were generated through interpolation of average monthly climate data from weather stations (see methods) on a 30 arc-second resolution grid (often referred to as "1 km2" resolution). Variables included are monthly total precipitation, and monthly mean, minimum and maximum temperature, and 19 derived bioclimatic variables. The interpolations were done by Robert J. Hijmans, Susan Cameron, and Juan Parra, at the Museum of Vertebrate Zoology, University of California, Berkeley, in collaboration with Peter Jones and Andrew Jarvis (CIAT), and with Karen Richardson (Rainforest CRC). We thank Arthur Chapman (CRIA), Pilar Hernandez (NatureServe), Niels Raes (Dutch National Herbarium) Mohammed Irfan Ullah (ATREE) and Catherine Graham for their help and suggestions; (iii) DEM90_M Raster file with the elevation (meters above sea level) for the ASARECA region, Resolution: 90m, Source: NASA, Shuttle Radar Topography Mission (SRTM))

Ritho, C.N. 2003. Review of Natural Resources Management Policy Studies in the East African Highlands (Kenya, Uganda and Tanzania). Department of Agricultural Economics, University of Nairobi, December 2003.

Ruddle, K. 1993. "*The Transmission of Traditional Ecological Knowledge*." In Traditional Ecological Knowledge, concepts and cases. IDRC and IPTEK, Ottawa, Ontario.

Russell D, Johnson D, Tanui JK, Mango N and Njui A. 2003. Landcare Africa/AGILE - Collective action and grassroots innovation in natural resource management in Western Kenya and Mount Kenya regions and Uganda: A synthesis, *AHI Working Paper* No 17

Sanginga, P and A Stroud, 2001, Assessment of the Impacts of Farmer Participation in Farmer Research Groups in the Highlands of Kabale, Uganda

Stroud A. 2002. Regional Synthesis: Operationalizing AHI Phase III – Developing Approaches for Improving Integrated Watershed Management, Moshi Tanzania on 1-5 October 2002. *AHI Working Paper* 14

Stroud A. 2003a. AHI Profile Report to ASARECA: Broadening Horizons - Institutional, Policy and Technical Innovations for Improving NRM and Agricultural Productivity in the East and Central African Highlands (2002-2004) P. 62 *AHI Working Paper 16.*

Stroud A. 2003b. Transforming institutions to achieve innovation in research and development. Chapter 5 In: Pound B, Snapp S, McDougall C, Braun A eds. Managing Natural Resources for Sustainable Livelihoods: Uniting Science and Participation. London UK: Earthscan Publications Ltd. P. 88-112

Stroud, A, 2004, Integrated Agricultural Research for Development: Lessons from AHI. Paper presented to the Rockefeller Foundation Grantees Workshop: Enhanced Soil Productivity in East and Southern Africa. September 20-23, Nairobi, Kenya, 2004.

Stroud A and Khandelwal R. 2003. In Search of Substance: An Analytical Review of Concepts and Approaches in Natural Resource Management in Sub-Saharan Africa. *AHI Working Paper* No 20. P. 74

von Zeipel, M. 1996, A decade of peace revives Uganda's wildlife and gorilla tourism *WWF News* 4.96.

Wangati F and M Loevinsohn, 1994. The African Highlands Initiative; A conceptual Framework. International Centre for Research in Agroforestry (ICRAF), Nairobi. pp.24.