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Land Use Change, Impacts and Dynamics

SUSTAINABLE INTENSIFICATION OF MIXED CROP-LIVESTOCK SYSTEMS

LUCID WORKING POLICY BRIEF # 1

How people use land has changed swiftly over the last half-century in East Africa. Two of the largest changes have been the expansion of mixed crop-livestock systems into former grazing and other more natural areas, and an intensification of agriculture.

The changes are a response to a mix of factors including land privatisation and other government policies, population growth and migration, and changing national and international markets for crops and livestock products.

The land use changes have allowed many more people to live on the land as farmers and agro-pastoralists, and the systems have shown flexibility and adaptability in face of changing international and national economic and political structures.

Some areas have undergone successful transformation of their agriculture, and land degradation that had been severe has been reduced with intensive land management practices.

In other areas, rural poverty is common and environmental resources are becoming increasingly degraded. The impact of yield declines has been compounded by a loss of communal land resources such as grazing land and woodlands. The linked poverty and land degradation problems are particularly severe in remote, semi-arid zones.

Key Questions

1. What can be learned from successfully intensified systems that can be applied elsewhere?
2. Are there common social or environmental conditions necessary for sustainable intensification to occur?
3. When does an area reach the “tipping point” when it becomes beneficial for people or communities to invest in improving their land?
4. What can governments or NGOs do to promote the conditions for sustainable intensification?
5. How can interventions be formulated to address the circumstances of poor farmers? Women farmers? Mixed systems in semi-arid zones?

Trend 1: Extensification

1. **The largest conversion of land use** in East Africa in the past 50 years has been the expansion of agriculture at the expense of grazing land. Prior to 1950, semi-arid and sub-humid areas were predominantly pastoral with scattered settlement and cultivation. From the 1950s to the present there has been significant transformation of grazing land to mixed crop-livestock agriculture.

2. **The rate of agricultural expansion appears to be slowing** in several areas (e.g., below Mt. Kilimanjaro on both the Kenyan and Tanzanian sides, and on the eastern slopes of Mt. Kenya). The slowing is occurring especially where the conversion frontier is in drought-prone land. The rate of rural population growth is also slowing in many places (WP 19, 20, 25). In other areas (e.g., Ugandan sites) the expansion of agriculture is continuing at a rapid pace (WP 14, 17)

3. **Driving Forces** include economic, policy and other reasons behind migration, population growth, the availability of land for settlement, and non-farm opportunities. Young families seeking land have historically conducted this expansion. Their migration is usually short distance towards the edge of the area already cultivated or on land belonging to their group. However, changes permitting new groups into an area or selling of land have led to rapid in-migration (WP 17, 19, 20, 25, 47).

UNEP GEF

4. **Policies have tended to favour crops** over livestock for access to land and technical and financial support. Adjudication or sub-division of communal land to private holdings have often resulted in a conversion to crops since the smaller holdings do not support herds of animals, and as families sedentarize (WP 17, 19, 20, 25). **Economic returns** to land in mixed crop-livestock systems are often higher than for pastoral livestock systems alone (WP 34).
5. **Communal land resources** such as for grazing, fuelwood and medicinal herbs disappear, a loss that affects the poor. As land is converted, the patchwork of cultivation and natural vegetation gives way to private farmland (WP 42, 47).
6. Meanwhile, **former methods of maintaining soil productivity**, such as shifting cultivation and long term fallowing, are no longer practiced. Erosion and declines in soil organic carbon and soil nutrients are often severe.

RAPID CHANGES IN MBEERE, KENYA

A region that may be moving towards intensification is semi-arid Mbeere District, downslope of Mt. Kenya and on a good road to Nairobi. The land near Kiritiri town converted rapidly— 78% changed from bush to farms between 1961 and 2001 (Fig. 1). Most land changed following land adjudication that switched tenure from clan to individual in the 1980's. Land use changes that may have occurred gradually with population growth and agricultural intensification occurred suddenly. Families could no longer maintain large goat herds on their plots, and cleared land for crops.

A field-level view revealed, however, that farmers were leaving many fields fallow due to low economic returns. The area being cropped was only 40%. Indeed, half of the husbands work primarily off-farm. Most women-headed families left behind stay poor as remittances are used for immediate needs.

Ironically, labour is thus a limiting resource along with cash and land for investing in soil management.

Many families are poor as farm sizes have shrunk, the prices of crops are low, and land has low productivity. Crop loss to pests, diseases and low rainfall is frequent. Use of soil inputs is relatively low. Soil conservation techniques have been installed in many areas, but water conservation practices are rare. A crop that is rapidly expanding is miraa (Catha edulis Forsk), and local leaders are worried about its social effects.

Farmers, meanwhile, are diversifying their food and income sources by working off-farm and selling fuelwood. They ask for higher-paying crops or livestock products. They are aware of the land management practices of their Embu neighbours on the upper slopes but find them expensive. Indeed, some sell manure to Embu. The impression is that Mbeere farmers are interested in moving to a higher-productive system, if conditions were right (WP 20).

7. **Issues in systems undergoing extensification and moving towards continuous cropping** thus include:
   a. **Fuelwood collection** is impacting watersheds and other natural resources (WP47).
   b. **Loss of communal** pasture, woodlands and other natural areas for grazing or collect (WP 42, 47).
   c. Land use change **from bush to grazing** tends to reduce organic carbon content, soil moisture, pH, bulk density and nitrogen. This does not affect forage productivity until grazing intensity reaches a certain level (WP 36).
   d. Land use change **from grazing to continuous cropping rapidly impacts soil properties**. Former methods to maintain soil productivity such as shifting cultivation and fallowing are no longer practiced. Erosion, leaching and removal of vegetation can be significant. Soil organic carbon (SOC) and the nutrients potassium (K) and phosphorous (P) are the most affected (WP42 pg 18).
   e. **Livestock raising evolves**: smaller herd sizes per family; fewer cattle and proportionately more goats and sheep; grazing is near the homestead or animals are tethered; and women are taking on more care of animals (WP 19, 23).

Trend 2: Intensification

8. **Intensification Drivers.** The transition towards sustainable, intensive systems has occurred in several of the LUCID study sites. In this transition, the demand for higher land productivity grows as farm sizes decline, family sizes grow, and/or as the commodity market expands or prices for commodities rise (Figure 2).
9. **Changes in soil and land management** during this transition period have involved 1) installation of soil erosion control techniques; 2) application of manure; 3) purchase of chemical fertilizers and pesticides, and 4) planting of trees and fodder grasses. In general, those crops that are marketed and of high value receive the most inputs, and those zones with the strongest market links apply the most inputs (Figure 3). These techniques require substantial labour and cash **investment** by farmers, and often agricultural extension support. Government, parastatal or NGO programmes were particularly influential in organizing erosion control, encouraging mulching, and supplying chemical inputs.
10. In situations **when programmes stopped**, such as during civil unrest in Uganda, the collapse of parastatals in Kenya or structural adjustment in Tanzania, farmers often stopped using chemical fertilizers or installing terraces. However, the application of manure and the planting of trees and fodder plants continued, perhaps because they require less capital and provide clearly realized benefits (WP 17, 20, 25, 38, 47).

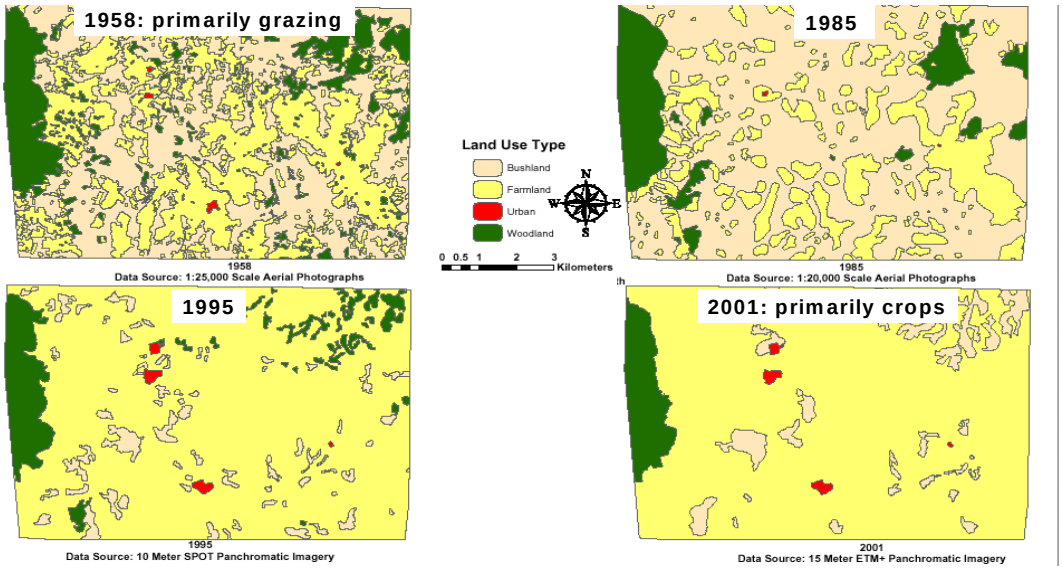

Figure 1. Land Use Change between 1961 and 2001 in the Kiritiri area of Mbeere District, Kenya. Source: WP 20 pg. 16.

11. **Intensified systems are in rapid flux** as farmers respond to changes in commodity prices and markets, labour availability, and governmental policies such as parastatal support. This has led to boom and bust cycles of exports such as tobacco, cotton, coffee, tea and horticulture. Farmers are moving to meet the national **urban market** demand for higher-end, easy to prepare food such as livestock products (meat, dairy, eggs), bananas and other fruit, vegetables and potatoes. These are expanding to new zones, such as dairy to semi-arid areas and bananas to former coffee zones.

12. **Who invests in soil management**. Not all farmers can invest in new commodities or soil management. Even in the intensive zones, the variation in soil productivity between households is significant. The lack of resources particularly impacts application of manure and chemicals. The variability is related to the number of adults and the gender of the acting head of household. The households investing the least on the land tend to be women-headed. **The absence of the husband from the farm** is closely associated with poverty. Husbands leave small farms to seek work, but once he is gone, wealth usually does not improve. Gender disparities and HIV-AIDS reinforce the precarious situation of poverty (WP 20, 24, 25, 47).

13. **The decline in soil productivity** is most dramatic in Kenya and Tanzania where nutrient levels (SOC, P and K) have sunk to low levels since the 1980's. The depletion is due to the land use changes as described above, and were probably made worse by the removal of fertilizer subsidies in the 1980s. The sandy soils in Kenya sustained higher losses than the clayey soils in other sites (WP 42 pg 18). SOC is highest in upper zones of Kenya under tea, coffee, bananas, woodlots and pasture due to management practices. In similar land uses in middle and lower zones, SOC is inadequate due to environmental and management factors. In the lower slopes of Mount Kilimanjaro in Tanzania, however, there is a regeneration of SOC under pasture and maize/beans due to manure and crop residues, mulching, and terracing. In Kenya, farmers report a decline in productivity in 37% of fields in Embu, 44% in Mbeere, and 54% in Kajiado, levels corresponding with soil management. Farmers credit manure for productivity increases and blame the lack of it for decreases (WP 19 pg 18, WP 20 pg 31, WP 42

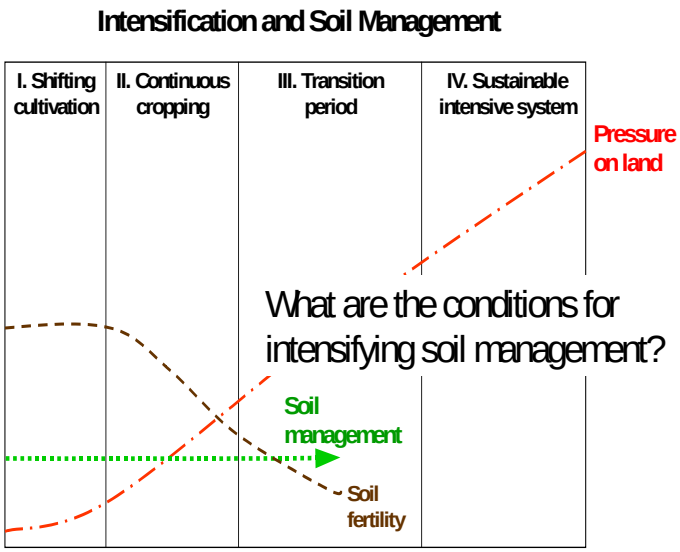

Figure 2. Graph of Intensification and Soil Management

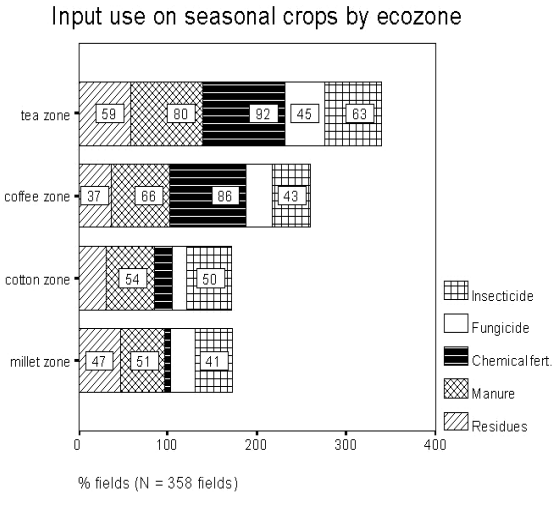

Figure 3. Input use on fields with seasonal crops in Embu and Mbeere Districts, Kenya (% of fields receiving soil inputs) WP 20 pg. 30.

14. **Irrigation** of high-value crops for the urban or export market is rapidly increasing. Environmental problems such as soil salinisation and water pollution due to high rates of chemical inputs and poor land management are appearing. (WP 19, 20, 23, 35).
15. **Issues in intensifying systems** thus include:

a. *Low and declining soil productivity* in many fields.
b. *Land management and soil productivity vary widely* between areas and households.
c. *Small and declining farm sizes*. Some families are near-landless in all zones.
d. *The systems are in constant flux* with changing commodity markets and prices.
e. *Governmental policy and programmes* have frequently changed affecting land management. These include access to credit, price incentives, subsidies for fertilizers and pesticides, import policies, the strength of extension services, decentralisation and centralisation of land management authority, and land tenure arrangements.
f. *Little community-level land use planning* to optimise water, grazing and woodlands resources.

Trend 3: Future

16. Economic analyses of returns to land under livestock, crops and wildlife conservation, and land use modelling, indicate that irrigation will grow and that cropping will continue to expand including into semi-arid savannas. This expansion of cropping will place additional people at risk of productivity declines and highly variable rainfall (WP 34, 48).

Summary

a. Land degradation is most rapid during the conversion of land use from bush to cropping.
b. The poverty/ land degradation relationship is real, reinforced by gender disparities.
c. The poverty/ land degradation spiral is not irreversible. As the agricultural sector becomes more profitable and other conditions more favourable, farmers invest in soil management.
d. Supportive policies and programs may have a large impact during this transition period, when economic returns to investment in the soil may be met in the short to medium term.
e. Non-farm income sources are essential to a productive and sustainable rural system.
f. The current and especially future situation is most critical in semi-arid areas—where the marginality and vulnerability of the human and environmental systems overlap.

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WP 48: Olson, J. *et al.* 2004. A Research Framework to Identify the Root Causes of Land Use Change Leading to Land Degradation and Changing Biodiversity

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LUCID is a network of scientists who have been studying land use change in East Africa and its implications for land degradation, biodiversity, and climate change for many years.

Data collection methods include Remote Sensing (RS) and Geographic Information Systems (GIS), vegetation surveys, soil sampling, wildlife counts, household surveys, group and individual interviews, and literature reviews.

Major institutional partners include the International Livestock Research Institute (ILRI) in Kenya, the University of Dar es Salaam in Tanzania, Makerere University in Uganda, the University of Bordeaux 3 in France, and Michigan State University in the USA

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