Project Description: "Hybrid Technologies in the Era of HIV and AIDS: Hand-hoes and Mobile Phones in Rural Africa"

Introduction

In a village of thatched huts north of a bustling truck stop on the Pan-African highway, a group of AIDS widows send out text messages using a member's Nokia handset and Celtel minutes. They are coordinating when to meet to roast, grind, measure, and mix a batch of nutritional supplements for their HIV positive members, bed-ridden chronically ill friends, and AIDS-orphaned youngsters. They prepare the supplements-- from locally grown maize, millet, sorghum, soybean, and cowpeas-- to meet local palates. These crops are grown by hand (with hand hoes) on nearby farms, saving on purchases of expensive commercial supplements from Nairobi, and promoting local trade. The supplement mix is packed into plastic bags, sealed with a candle, and arrangements are made (by mobile phone) for pick up, and the packets distributed at cost through a local HIV/AIDS agency. Demand is so large, they cannot keep up.

HIV/AIDS, now entering its third decade as an epidemic disease, is a major demographic, economic and human development challenge for the African continent. With 26 million current infections and about 3 million deaths in just the last year (UNAIDS 2005) in Sub-Saharan Africa, the HIV/AIDS pandemic has become a powerful figure in the donor landscape and a major force transforming the rural landscape. The disease brings cumulative and unprecedented losses of labor, capital, the knowledge of adults in all walks of life, and sources of care for a young generation. This transformation is thus both literal –it is changing farming and land management practices and thereby vegetation cover—and it is metaphorical, in that it is altering power structures, discourses, and material resources, which are often diverted from malaria control, poverty alleviation and rural development (Kalipeni et al 2004).

Across the continent HIV/AIDS is a major problem for human and economic development, and not just a medical sector or public health issue (Barnett and Whiteside 2003). The Kenyan president declared HIV/AIDS a national emergency in 1999 (NASCOP 2003), and government and non-governmental agencies are incorporating awareness about the disease and its impacts into education, agriculture, rural finance, and other sectors. Institutions from grass-roots community-based organizations (CBOs) to non-governmental organizations (NGOs) to ministries are adapting their policies and approaches to recognize HIV and AIDS; this "mainstreaming" of HIV/AIDS concerns within ministries, NGOs and donor agencies has become standard (USAID 2003, Holden 2003).

The epidemic is not yet under control, however. Even if national prevention efforts were to suddenly succeed where to date they have not (Campbell 2003, UNAIDS 2005), the ramifications of current levels of infection, untreated chronic illness, premature death and infant mortality will be felt for generations. This is especially true for pockets of high prevalence (over 10%), such as in western Kenya. This is true even though national statistics show progress; for example, Kenyan rates of prevalence of HIV infection declined from 10% nationwide in the late 1990s to 7% by 2003 (DHS 2004). Each village faces its own micro-epidemic based on the particular conditions which shape risk of infection, access to care and treatment, and subsequent ability to absorb and mitigate impacts of illness and death of many working-age adults (Barnett & Whiteside 2003, Kalipeni et al 2004).

The proposed village study site (Figure 1) represents one such pocket of severe micro-epidemic, owing to a history of labor migration to earn income to complement small-scale farming, and its location near trade and transport routes between Kenya and Uganda, both of which are classic "risk factors" for infection with HIV. Poverty, poor nutrition, and inadequate health care mean that HIV infections spread rapidly and lead to untreatable opportunistic infections, chronic illness, and premature "working age" adult mortality within 7-10 years of infection. About one-third of households are "AIDS-affected"

through illness, death, and care for orphans (Murphy, Kassam, and Kesekwa, 2006). Many more are likely to be HIV+, but non-symptomatic, untested, and unaware. Access to voluntary counseling and testing is scarce and distant; access to life-extending anti-retroviral therapy (ART) is poor. These medicines became available in Bungoma in 2004, but their high cost ensure that they will reach only a minority, as is the case throughout rural Africa (UNAIDS, 2005).

The study is motivated in part by this humanitarian imperative and the practical demands involved in combating this incurable disease that is now generalized throughout much of rural sub-Saharan Africa. Lives and livelihoods are challenged by the threat of infection and burdens of AIDS; these challenges lead to new grassroots technical and social innovations; they bring new actors, messages, motivations, and resources.

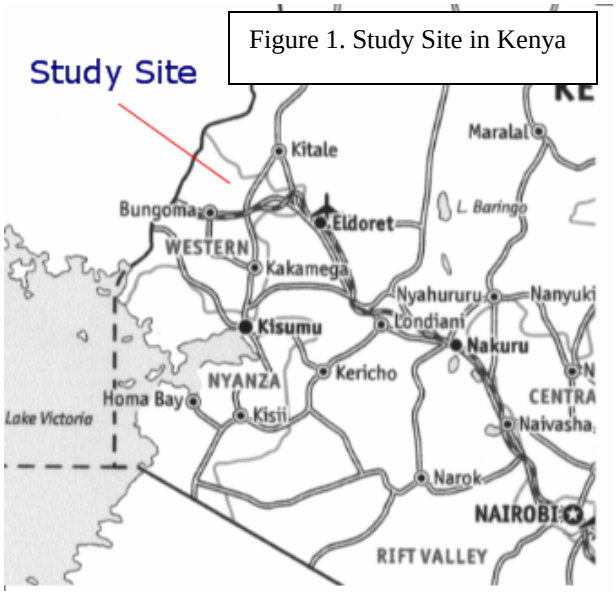

Figure 1. Study Site in Kenya

Local innovations span a spectrum from "software" to "hardware". Social innovations include HIV positive and AIDS-widows support groups, microcredit schemes, and AIDS orphan mentoring programs, from Lesotho to Ethiopia; infected persons increasingly try to "live positively" (i.e., productively, often openly, as an HIV + person). Urban sex workers have found ways to reuse the "female condom" to avoid HIV infection--especially important when the male client refuses to use a male condom: they wash the female condom with a locally available, cheap "sterile solution": beer (WHO, 2002). In South Africa, a computerized pill bottle and mobile phone message help patients adhere to complex anti-retroviral therapy (ART) regimes (Kahn 2004, 2005). Websites dedicated to HIV prevention and AIDS mitigation reach not just the urban resident but the rural teenager who can seek out information he can't get at school without fear of harassment (WiRED 2004). Numerous listserves link specialists in nutrition, prevention, treatment, mitigation and other fields (Driscoll 2001).

Because AIDS illness and death depletes the rural adult workforce, many argue for introducing "labor-saving" farm technologies, such as animal traction and drip irrigation (Action Aid 2005, Du Guerny 2002, Steiner et al 2004). Indeed, AIDS widows in Zimbabwe evidently banded together to design a lighter ox-drawn planter (Mutangadura et al 1999). These arguments already influence donor investments (Reliefweb 2005) and shape international NGO programs and policies, but are based on modest empirical evidence and may not be relevant to many (Mather et al 2004; Murphy et al 2005). More likely, subtle and incremental technologies using available local assets help ease seasonal labor crunches, reduce the drudgery of work, and produce food: these the recovery of (labor-intensive) neglected indigenous, nutrient-rich leafy greens (Anon ND, Anon 2005b, ACE-Africa 2005).

Theoretical Insights and Intellectual Merit

This study is motivated by curiosity about, and respect for, the grass-root perceptions, uses and creative adaptation of global technologies (the cellphone, anti-retroviral therapies or ARTs) alongside traditional herbal remedies, crops, and kitchen gardens. Academic and applied research has influenced our understanding of contemporary technology change in rural Africa; but a large gap persists in the scholarly literature. The intellectual merit of this study is that it targets this gap: it will illuminate dynamic

social networks of contemporary technology change, highlighting specific marginalized populations who have tended to lack a voice in constructivist approaches to contemporary technology: the economically disadvantaged, ethnically and culturally diverse, and geographically remote (from universities) of rural Africa. In a globalizing world, hybrid systems are fast emerging, yet little scholarship provides objective, empirical, yet theoretically rich and normatively grounded studies reflecting these users' points of view.

This study is strongly influenced by the "social shaping of technology" school (MacKenzie and Wajcman 1999, Jasanoff et al 1995, Dierkes and Hoffman, 1992), which encompasses studies of the social construction of technology (Bijker et al 1987, Bijker and Law 1992), actor-network approaches (Latour 1987, 2005), history of technology (Cowen 1983, Fox 1996, Misa 2004), cultural dimensions of technology (Akrich et al 1992, Herschok et al 2003, Sturken et al 2004), local resistance and appropriation (Eglash et al 2004), political content of technology (Winner 1977) and more. Theoretically rich and abstract, these academic approaches contrast with informative but theoretically thin, sectoral, applied research by development agencies focusing on, for example, small-scale agriculture (FAO 1995; Gari 2004) or potential of the ICT (IDRC 2005, Driscoll 2001, PANOS 2003). In anthropology, economics, and development studies, a large literature pertains to innovation and change in rural agricultural societies, technology transfer within development, and the significance of information and communication technologies, discussed below.

Technology among the rural poor in less developed countries is not necessarily applied science or the product of engineering, but it is a fundamentally human and social endeavor: It is "what people do." Technologies are complex social systems, emerging out of a dynamic and historically grounded social process and influenced by power structures, cultural norms, and social, environmental, and economic realities. The technology choices represent not necessarily the best technical solution to a problem, but the result of contingent decision-making by differentially empowered social groups who help define "the problem" and the standards by which a solution is deemed acceptable and stabilized. From bicycles to the modern electrical grid to advanced weapons systems (MacKenzie and Wajcman 1999), different social groups influence (or are left out of) the process of design and manufacture; they posses different perceptions of the technology and its purpose and value to them; this leads to an appreciation for the "interpretive flexibility" of technology (Bijker et al 1987). The rise of the modern safety bicycle in the 19th century illustrates this process and the need to appreciate designs which "failed" (the penny-farthing cycle) to appreciate the many choices made before a dominant design (the "safety bicycle") emerges (Bijker 1995). Increasingly, different user are recognized for their distinct contributions to shaping technology design, manufacture, use and marketing, and in turn are affected (Oudshoorn and Pinch 2003; Rosen 1993).

The modern information-communication technology apparatus is increasingly a topic of study and excitement for development professionals (IDRC, 2005) as well as for academic study of the social shaping of technology. The internet is integrated into and changing social movements (Stonich, 1998) and new forms of economic activity ("just in time" and flexible manufacturing). Castells (1996, 1998) documents the fundamental societal changes wrought through and by the network society, in which the "space of flows" of resources, power and ideas overtakes the "space of places" of grounded physical reality. Being connected to the network provides access to global resources through the "space of flows"; it leaves others disconnected, often those residing only in the "space of places," whether urban slum or rural hamlet.

With few exceptions, scholarly studies and publications in the social shaping school have focused on the affluent West and ignored developing countries (Shrum and Shenhav 2001). A few exceptions in the scholarly literature discuss the international science enterprise and networks of communication (i.e. focus on the internet, Shrum 2005), the rise of non-governmental organizations as researchers (Shrum

2000), or alternatively, decry the neglect of indigenous knowledge systems in international agricultural research (Opole 2003).

Another large body of research has attempted to explain and predict agrarian change since the 1960s. Variously emphasized are external influences who induce innovation (Hayami and Ruttan 1979), endogenous change through increasing population density (i.e. Tiffen et al 1994), environmental factors (Biggs and Clay, 1981), access to markets (Pingali et al 1997), and land tenure, income, and education (i.e., Feder et al 1986). Western, modern technology has often been assumed to be a positive good in these studies of technology transfer and innovation. Alternative models challenge such ethnocentricity of top-down modernization, putting "the farmer first" (Chambers, 1997) and highlighting local innovations and dynamic knowledge systems among farmers (Richards, 1985; Reij and Waters-Bayer 2001) or rural artisans (Swiderski 1995, Gamser et al 1990).

The diffusion of innovation approach (Rogers 2003) is widely used to model how global technology transfer to the developing world, from the West. It provided useful classifications: concepts and labels such as "innovator" , "laggard" , and "change agent" , the "complexity" or "relative advantage" of an innovation. This approach is thus drawn on to explain the spread of HIV/AIDS prevention ideas (Bertrand 2004, Singhal and Rogers 2003), the Green Revolution package of improved agricultural seeds, tools, fertilizer, pesticides, and irrigation; and many other technologies (Smillie 2000).

Discussions of technology change in developing countries are also greatly influenced by the 1970s era Appropriate Technology movement (also Intermediate Technology: Schumacher, 1975), institutionalized in an organization now called Practical Action, formerly Intermediate Technology Development Group (ITDG). The original aims of devising "small, simple, cheap, and non-violent" technologies captured the hearts of generations of Peace Corps and other volunteers; biogas digesters, foot treadle pumps, and bamboo reinforced water tanks were, however, not always relevant to local users nor sufficient to help them get ahead. Smillie (2000) critiqued NGO and donor programs for inadequacies in design, irrelevancy of focus, and neglect of gender roles, among many issues in implementation. The movement's proponents focused on technical designs and preconceived basic needs of the poor; ronically, they could not overcome structural disparities in access to technologies (Shrum and Shenhav 2001). The movement did at least make visible the myriad practical problems involved in translating global (or at least western) technologies to a specific local context.

In development studies, the proverbial "black box" (Winner 1993) is opened to reveal a process of deployment of international aid and technical assistance through the "development apparatus" (Ferguson, 1994). Projects and plans do not always achieve the official objectives, but do have unintended consequences. They nurture a class of petty bureaucrats, uphold the rural elite, and disguise the political dimensions of nominally technical assistance. Fish-ponds were dug by Zimbabwean farmers not to raise fish for income and nutrition, but to secure land rights, gain access to project resources, and receive future project aid (Crewe and Harrison, 1999). The apparently straightforward technical problem: how to "transfer technology" is revealed to be a complex social process which will both succeed and fail in surprising ways. Similarly with the deployment of resources targetted to and through "HIV/AIDS"; outcomes are not necessarily attributable to technical considerations (reducing infection, improving care) but reflect political and social aspirations of the actors following stated policies for "HIV/AIDS mainstreaming", and aiming to access funds, and stay on good terms with donors (Booth, 2004; Nkwena 2005).

These theoretical insights offer a way to understand and appreciate the hybrid systems that are emerging in rural Africa today. Local-level individual and group resources and motivations shape the trajectory of rural technology change, but these are affected by networks of flows which include/exclude actors in specific ways. Furthermore, we cannot comprehend processes in a Kenyan village today without

acknowledging the influence and potentially unexpected effects of the HIV/AIDS and larger development "apparatus.". Another, normative lens of human development helps us assess whether changes are beneficial, in what way, for whom. The paradigm of Sustainable Human Development (Sen 1999), institutionalized in the Human Development Index (HDI: UNDP, 1990), argues that development is about expanding freedoms, and income is simply instrumental to the intrinsic good of enhancing these human capabilities: to live longer and with dignity, to lead fulfilling lives, to participate in society, to walk about without shame, to raise a family, to enjoy the smell of roses while generating a tiny income from cultivating and selling flowers (Alkire 2002). This ethical framework underlies the choice to examine marginalized rural populations in Africa who are facing HIV and AIDS. It suggests that appropriate technologies are those which allow people "to do more and be more" in ways that are meaningful to them. The prosaic hand hoe persists and is intertwined with the costly mobile phone because both promote distinctive yet inter-related human freedoms; yet their specific forms and uses are not preordained nor fixed. This process is worthy of examination.

Linking the handhoe & handheld in rural Africa

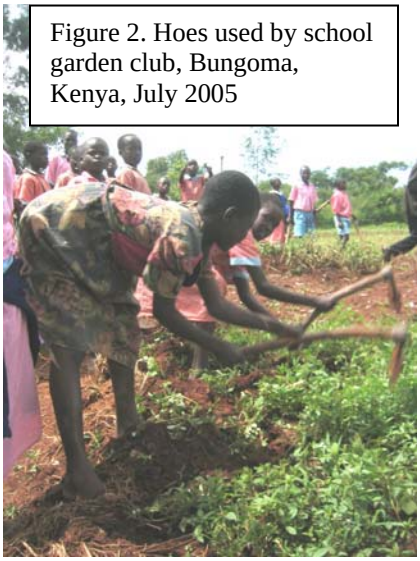

Figure 2. Hoes used by school garden club, Bungoma, Kenya, July 2005

The Hand Hoe

Anthropologists have documented hoe emergence in antiquity around the world in similar simple shapes and with similar local materials: wood, stone, and later iron (Kramer 1966). Now, the short-handled, iron-headed hoe (Figure 2) is the most important implement to the poor rural household in Kenya as elsewhere in sub-Saharan Africa. It remains one of the most neglected technologies in academic and applied development literature, hidden in the larger "seamless web" (Bijker 1995) of social, economic, political, historical, and environmental factors which comprise agriculture.

The hoe is commonly associated with the rural woman food producer in Africa (Bryceson 1995). Used with intimate and sophisticated local knowledge of soil, moisture regimes, and varieties of crops; the hoe produces food and income. Women handle fine soil cultivation, planting, weeding, harvesting and heavier tasks as needed, which is increasingly the case with AIDS. Hoes are used by men but for different tasks: heavier brush clearing and initial crude land preparation, and constructing terraces and water ponds. Weeding is one of the most onerous tasks in small-scale agriculture and it falls mainly to women. Animal traction (i.e. the ox-plough) has been promoted more than hoe techniques through extension services, but has not taken off in many locations, in part because the subsequent increase in ploughed area simply leads to more work for women in weeding. With AIDS, new uses of the simple hoe include addressing new tasks (pile composting) for new crops (leafy greens, medicinal plants) by new individual and group users (Table 1). While universally used in rural areas; however, they are not actually universally owned. About 20% of households in one study village lack any hoe (Murphy, On'gow, Ouma, Omondi and Gori, 2006), reflecting the vicious cycle of destitution brought by AIDS. The typical 3 pound iron-hoe blade might last only 2 years. Many cannot buy a new hoe when the old one is worn and broken. Local repairs are inadequate, blacksmiths rare, and scrap metal, scarce.

Hoes in rural Africa are not science-based devices. More is known today about design and use of specialized handhoes in colonial Williamsburg, Virginia (Egloff 1980) than the contemporary uses and weaknesses of hoes for rural Africa. Agricultural engineers instead focus on more sophisticated farm implements (Ahmed and Kinsey 1984, Mothander et al 1989, Pingali et al 1987). No research institutes

are systematically testing metals and manufacturing to produce stronger, sharper, lighter, more durable hoes.

The typical Kenyan hoe has thus not changed much since the late British colonial era, i.e., the late 1940s and 1950s (Chillington cited in Egloff 1980); when factory imports displaced local production, and a few hoe-heads became standard on small-farms and estates. The imported 3 pound heavy blade is common in local agricultural supply shops, selling for about $2-3 dollars; other sizes are occasionally seen. This process of stabilization did not, until recently, seek out the opinions of rural women and other users and does not reflect the range of current, real preferences. Hoe ergonomics has begun to receive attention out of concern for women's workload (IFAD 1997) and for the impacts of AIDS (Bishop-Sambrook 2004).

Table 1. Comparison of Attributes of Hoe and Mobile Phones in Rural Kenya

Technology	HAND – HOE	CELLULAR / MOBILE PHONE
Attributes		
History	Wooden hoes, digging sticks since antiquity; iron hoes, late 19th C; imported manufactured hoe, 1920s, standard types & sizes, 1940s.	Since 1997 in Kenya, rapid diffusion since 1999. Many brand new users
Conventional Uses	Weeding field and garden crops, light land preparation	Voice and text communication for work, urban users; Mostly domestic, some international. Replaces email, internet, transport
Adaptive uses	Hoe used for major land preparation, soil movement; Buy large hoe, wear down through use to make lighter tools for women, children. Adjust handle angle, vary posture, attack for different tasks	Flashing/ beeping; public use/rental; charging phones as local enterprise; charging from car battery and solar panels; detailed knowledge of signal access in remote areas; cellphone as primary internet access
Public Access	Village self-help groups, charities; sharing among users in a group	Private subscriber rents out handset and minutes; Informal village network for SMS
Cost	Low, US $2-5 for iron head	High, about $75 for handset & SIM card plus $.35-.50/min voice and $.10/ text message
Complexity	Simple device, sophisticated knowledge system (techniques for cultivation)	Complex hardware and software (interface, tariff structure, technical assistance)
Constraints	Lack a hoe; poor quality, lack of repair; lack of blacksmith, welder, & scrap metal; little variety in shape, weight. Poor ergonomics; Labor shortages (acute and chronic) for AIDS affected, youth, elderly	Cost of buying and maintaining system, charging/power supply, theft, lack of cellphone towers in remote areas; complex interface (sounds, alarms, messages, voice mail)

The former suggests that a longer handled, straight posture hoe is not generally acceptable by women: they fear being viewed as lazy, not bending over in the field. The second suggests that lightweight hoes and tools would be desired by AIDS-affected. Different tasks and soil conditions require

different head weights and shape, and different handle lengths. Most rural households, however, lack access to desired wider offerings; aid agencies often oversimplify needs, arguing simply for "lighter weight" tools for AIDS affected (and weaker) widows and children (Mutangadura et al 1999, Bishop-Sambrook 2004). Fieldwork in AIDS-affected villages in Kenya revealed that farmers want heavier tools, as they make some critical tasks, such as land preparation, much easier.

The hoe is persisting as a cheap and essential implement for food security, and recently it is gaining renewed interest. Global movements for conservation agriculture (or related organic, permaculture, and bio-intensive farming) emphasize "minimum-tillage" techniques for soil and water conservation, and non-chemical, locally prepared organic pesticides. These are finding an appreciative audience among the soil and water scarce, and AIDS-depleted small farm sector of Sub-Saharan Africa (Steiner et al 2004). These techniques require and thus bring new attention to hand tools, their limitations and scarcity.

Mobile phone

The cellular or "mobile" phone presents a stark contrast to the hand hoe in terms of attributes such as its history, policy environment, complexity, cost, manufacture and supply, as summarized in Table 1. One of the more popular information and communication technologies (ICT) in the developing world (Wright 2004), it seems to meet a demand for everyday horizontal communications that more trendy internet and email have not met, despite much attention and excitement (Anon 2002, Merker et al 2002, IDRC 2005).

This remarkable history is recent: The first mobile/cellular phone call in Africa was made in Zaire in 1987 and the industry has taken off since then (Chango 2005). Mobile phones are classic examples of "leapfrogging" technology, overtaking landlines. In 19 African countries, mobiles make up three-fourths of all phones in use. Kenya has seen 170% growth over 1998-2003, with 1.6 million phones in use, and 5 mobile phones (vs. one landline) per 100 persons. Africa has over 75 million mobile subscribers, a figure projected to rise to 200 million by 2009 (Steinbock 2005). While most are urban, the rural market is growing (PANOS 2003).

Growth is attributed to liberalization of the cellphone industry since the mid-1990s, along with poor conventional phone services, and the high cost of extending landlines across a lightly populated continent (Panos 2003, Vodafone 2005). The World Trade Organization (WTO) passed its Basic Tariff Agreement (BTA) in 1998, which required countries to open up telecommunications sector to cellphone companies. Subsequently Kenya (among others) broke up its national monopoly on telephone service, started up Safaricom cellphone service, set up regulatory boards, and opened up space for a competitor cellphone service, Kencell (now owned by and called CelTel). CelTel and Safaricom are the two main cellphone companies in Kenya, complemented by an exclusive, but growing satellite phone market.

The mobile phone provides utility as well as prestige, but in most of Africa this does not come cheap. In Kenya, it costs about Ksh 10,000 (US$60 to $100) for the simplest handset and basic service; while decent daily young professional wages are Ksh 3000 – 5000, and Ksh 100 for a laborer. A voice call can cost Ksh 30 or $.50 per minute, so users prefer cheaper prepaid phone cards and text messaging (SMS), which sends more information more cheaply (and often overcomes weak signals, since text messages travel when voice communication often does not). Lack the cash to buy a phone card? You can "flash" another: dial, wait for the ring, and hang up; your phone number shows up as a missed call, you avoid any charges. The growing global market in "selling to the poor" (Hammond and Prahalad 2004) is recognized by suppliers and manufacturers. A cheaper tariff was launched recently in Kenya specifically to reach more low-income consumers, part of a larger global marketing trend to sell more to the poor.

An airtime sharing service ("Sambaza") which allows users to send airtime to another phone is being appropriated as a cheaper way to send remittances and school fees (Anon 2005e, Wright 2004).

Despite the cost and complexity of mobile phones—their interfaces, menus and options can be bewildering even to computer literate operators-- they are found in the hands of women farmers, AIDS support groups, village chiefs, bicycle taxi drivers, itinerant traders, and community organizers. Many poorer rural users are partial-adopters, not owning but occasionally visiting a private mobile phone shop (Reck and Wood, 2003) or borrowing from a friend. Self-help groups buy and maintain a handset to support income-generation schemes, and farmers communicate through text messaging to access commodity prices and find buyers for their maize (KACE, 2005). Children are conscripted as runners to relay messages received through a communal handset to recipients in the village (Vodaphone 2005, Panos 2003). Rural users know where to get a signal in remote areas, climbing to a specific hilltop, for example.

Other novel uses of the mobile phone involve running (and helping to win) the Rainbow Coalition's Kenyan presidential campaign in 2002. Spreading HIV information is another: young subscribers are targeted through the E-Quest contest of HIV/AIDS knowledge in Kenya (PATH, 2005) and similar applications in Nigeria (Anon 2005g). Health professionals share vital information with patients, including reminders to take medication via cellphones (Khan 2004). The cellphone network is being tapped into for internet access, a costly niche with a market in NGO workers and other professionals.

Reaching friends and family is an important use, followed by work and business concerns, according to one rare survey of African subscribers (Vodafone 2005). Mobile phone calls and messages replace travel costs and time, and are not just a complement to landline. The mobile is not simply a luxury personal consumer good; it builds and maintains social capital and relationships, enhances family bonds. These can span large distances through long-distance labor migration and multi-location residence to maintain rural ties to land and clan.

Current mobile phone systems, while spreading and finding markets, do not address needs of the African rural poor, however, and designs are changing (slowly). Spurning trendy accessories and miniaturized handsets found in Western phones, the rural poor value instead cheaper devices. The new Ultra Low Cost handset (Motorola's ULCH) might be one solution (Anon 2005d, Taafe 2005). Other welcome designs would be rugged devices that withstand mud, water, heat and vibration; screens visible in full daylight; simpler interfaces for the less literate; larger antenna to facilitate reception of signals; and larger capacity (i.e. probably heavier!) batteries. Lack of access to electricity is a problem that solar chargers might address (Blyth 2005). Meanwhile, tiny phone charger-shops comprise a single power strip proliferate in small towns fortunate to be attached to the centralized power grid (or a generator or car battery).

Why is the hoe, a cheap, short-handled heavy tool, so stable; while mobile phones are changing at a bewildering pace? How are these costly mobile phones being used by rural poor who lack even a $3 hoe? Why are labor-intensive farming practices now taking off among the acutely labor-short AIDS-affected, and how does the mobile phone facilitate these activities? Uses of hoes and mobile phones by poor, small-scale farmers represents a clash and synthesis of the old and new, the simple and complex, and the local and global; a fusion of technologies that is shaped by disease, aid funding, and hope.

Hybrid Social Systems in the era HIV and AIDS: Handheld Hoes and Mobile Phones

The mobile phone and hoe are emblematic of local/global hybrids. Plants scientifically designed in laboratories grow alongside traditional land-races saved in plastic jugs and wicker granaries; together

they combine the advantages of preferred taste and reliability for local agro-ecologies, plus scientifically bred higher yields and precisely defined pest resistance (i.e., to a specific grain borer). Bicycle taxis spreading through western Kenya, part of an inter-modal transport to carry chickens, TV sets, mattresses, and AIDS-patients (Maino 2002). Email list-serves diffuse traditional African herbal remedies for the treatment of opportunistic infections and reduction of viral loads (TICAH 2005).

The intersection of the mobile phone into communities relying on handhoe for livelihoods is one hybrid technology system that merits special attention. They offer an interesting contrast of sectors (agriculture, communication) and attributes (ancient vs. modern; low vs. high cost, simplicity vs. complexity: see Table 1). Both have been understudied relative to the more popular internet in the 1990s (i.e., Castells 1996, Stonich 1998, IDRC 2005) and animal traction and mechanized farming in the 1970s and 1980s (i.e., Ahmed and Kinsey 1984, Pingali et al 1987). The mobile phone might be a "labor-saving" farm technology neglected by conventional technical assistance projects. Jointly they can stimulate new forms of enterprise and association to meet today's concerns: i.e. where AIDS support groups produce their own nutritional supplements. Finally, they enhance diverse human capabilities, like the ability to improve health, participate in social groups. These two devices offer synergies in addressing the concerns of some of the poorest and most marginalized people in the world.

Each device is procured and used separately, from different shops and suppliers, yet the diffusion of one shapes possibilities for change in the other, and these dynamics influence local community group action, household labor-allocation decisions, and even the imagination. Applications of the mobile phone can make hoe-based livelihoods acceptable for rural youth who have been schooled against it. Being sent out to weed or plough has been standard punishment for wayward pupils. Decades of emphasis on Western-style education through secondary school if possible, and often in distant boarding schools, has conditioned the young to abandon the farm and seek urban livelihoods—and put themselves at greater risk of HIV infection. Now, labor- intensive kitchen gardens are being made "modern" (but might look much like their grandmothers') through knowledge-intensive, cellphone-enabled marketing of high-end horticulture and medicinal crops to the HIV/AIDS-affected and the affluent urban consumers. The hope that this approach will make farming more acceptable and feasible for today's youth underlies the activities of one organization promoting organic horticulture and school farming clubs to combat HIV and AIDS for the long run as a livelihood challenge, rather than just a disease (ACE-Africa 2005)

The process of technical change is profoundly social and political, as it is the product of decisions by actors with particular interests, access to power, and voice. It is associated with HIV/AIDS, constrained by historical events, nd influenced by priorities of international agencies. The relevant social groups who play a part in these hybrid technology systems -- from the end-user in the village to the national and global policy arena--are summarized in Table 2. The first two columns describe conventional users, suppliers, and policy actors; the third indicates <u>additional</u> actors in hybrid technology systems.

Important external catalysts for change throughout rural Africa, whether of individual health behavior, group farming, or electronic communication come labeled as "HIV/AIDS". These are nutrition schemes that target the HIV positive, training for home-based care workers who treat the bed-ridden, and instruction for "at-risk" youth in intensive organic (hoe-based) farming. The epidemic as actor yields new users and non-users: the chronically ill, patients on ART, school clubs, school-leavers, elderly widows and caretakers. A handset owned by a home-based care (HBC) worker who attends the AIDS-affected can help can help neighbors learn to grow nutrient-rich local greens, tubers and legumes, now widely perceived as health-promoting and income-generating because of messages brought by HIV/AIDS projects. Women's self help groups that once raised funds for water tanks are relabeled and function as widow and orphan "support groups;" they now raise crops, make nutritional supplements, and raise some cash to buy blankets for AIDS orphans. They use (someone's) mobile phone to coordinate these activities and try to save time among women who regularly have 15+ hour workdays.

These actors – the food producer, care-taker, school club, AIDS patient, medical doctor; the international NGO, Kenyan ministry, manufacturer, and retailer; and even the handsets, hoes, and HIV itself—belong to a network, a social and political process which patterns the diffusing, innovation and rejection of specific technologies. This network has its origins in colonial era labor-migration patterns, 20th C development and modernization policies, and traditional ethnic norms favoring higher fertility, attachment to land, and communal values. Local options are now affected by the World Trade Organization dictates which affects national telecommunications policy; they are affected by President Bush's AIDS relief plan (PEPFAR: see OGAC, 2005) and its funding priorities which force aid agencies to emphasize abstinence and behavior change (the ABC model) instead of tackling structural violence, and to purchase costly US brands of ART instead of lower-cost alternatives. Local options are still, however, grounded in local realities: the vagaries of soil and rainfall, the demands of mouths to feed, and the acceptance of corrupt government. Through participation in HIV/AIDS projects, farmers gain access to a network of influence to power and resources that can provide new skills and perhaps influence policy and design the next generation of mobile phone technology.

Table 2. The Hand-Hoe & Mobile Phone: Relevant Social Groups in Network

Social Groups/Actors	Hand-Hoe	Mobile Phone	Hybrid System
End – users	rural adult women, men, Gendered access, use, tasks	Urban professionals, wage workers; humanitarian, conservation, tourism sectors	Children, youth, elderly AIDS-affected) groups; community organizers, teachers; shared owners (groups)
Manufacture & supply	UK, Chinese, Indian, Zambian, UK manufacturers; local blacksmiths (rare); locally made handles	Handsets (Nokia, Samsung, etc); Service Providers (Safaricom, Kencell) =Vodafone and Telkom consortium); SIM cards	HIV/AIDS projects, groups, second-hand handsets, Ultra low-cost handset (i.e. Motorola); knock-off batteries; village generators, phone shops
Retail & Marketing	local stockists, hardware stores; Virtually no commercial marketing; farmer field days	urban billboards, TV, magazine, newspaper advertisements; high end urban cellphone shops	First-hand experience, phone shops; NGO social marketing projects, AIDS care programs, HIV prevention programs, CNN (satellite cable in market towns)
Research & Development	Virtually no research on tool, use, manufacture; some ergonomics	market research; applications of computer-based science and institutional innovations	Pilot projects, farmer field schools, conservation agriculture projects, rural ICT for development
Policy-makers	Colonial authorities; Ministries of Agriculture; Industry, Commerce	Kenya Communications Commission, WTO (BTA); Fiscal policies (luxury taxes)	Participatory policy-making, mainstreaming of HIV/AIDS, "ICT4D" movement, the non-governmental/civil sector

Technology change is not all positive; but it is not exactly neutral, since access and form of technology are socially constructed, and differentiated through digital, material, social, and geographic

divides. The social process leaves behind the "disconnected": the less-educated, poor, landless. It leaves behind those ashamed to be associated with the (HIV/AIDS-related) message or the messenger, who miss out on opportunities to learn, earn, and live (i.e., with enhanced nutrition, care, and even ARTs). Some changes represent improvements in human development (i.e., social innovations in forms of wife inheritance, or circumcision using razor blades). Other result in losses of local diversity or inter-generational transmission of knowledge; these might well be mourned as they are superseded by hybrid systems.

Research Questions

How are local and global technologies converging and being adapted by rural AIDS-affected communities? This study tackles this larger question through observing how the hoe and mobile phone are used in a specific AIDS-affected setting.

Specific questions are:

- *How are the hoe and mobile phones being used and changing the use of the other, and becoming integral parts of new rural livelihood strategies among HIV and AIDS affected?* What are specific end uses (food, family support, income), what are new livelihoods? What actors and actions are left out of this network of diffusion, use, and adaptation?

- *How does "HIV/AIDS" influence these technology changes?* How does the presence of HIV (the desire to avoid HIV infection or to live positively as an HIV positive person) and AIDS (burden of care for the ill, support for orphans, etc.) affect hoe and phone uptake, use, and adaptation? Does the stigma around HIV/AIDS prevent some from participating? What relevant resources are channeled through networks of institutional actors responding to HIV/AIDS?

- *What are useful entry-points for external actors to influence technology uptake and adaptation in ways that enhance human capabilities?* Given unpredictable outcomes of the development apparatus, how can external agencies act to broaden the network, ie. remove barriers to participation and enhance local innovation and adaptation of technologies?

The setting for field study is a village ("K") of about 2800 persons residing in 350 households. This village is located in the northern part of Bungoma District, Western Kenya (Figure 1 above indicates the approximate study site location), and was the location of prior fieldwork.

This region has suffered high rates of HIV infection: upwards of 40% among women at prenatal clinics have been tested HIV positive (DDP 2001), and about 20% of households in the proposed village site are currently directly affected by illness or prior death. Poverty is chronic and deep: Bungoma district ranks among the worst in Kenya in measures of cash income (a majority live below the poverty line of 1$ per day: DDP 2001). Housing is simple wattle and daub with thatch roofs more common than galvanized tin roofs (a sign of relative wealth). Physical infrastructure is poor: roads are rough dirt tracks, water is from shallow wells and streams, and electricity reaches only major towns and some market centers. Livelihoods are based on a combination of small-scale farming and wage income.

Despite poverty levels, social and technological change have been constant and subtle. Changes in the past five years include improved sweet potato and organic farming techniques, solar lighting, bicycle taxis, mobile phones, and (in a market town 5 km away) internet access. Some of these changes are due to new institutions, such as colonial authorities and Christian missionaries in the early 20th Century, who

brought clothing, the iron-headed hoe, and maize. Migrant workers return from other parts of the country with seeds, cash, and ideas. External actors from small, local organizations (ACE-Africa) to international rural development (CARE), appropriate technology (PATH) and child sponsorship (World Vision) agencies bring new ideas and aspirations, plus per diem, volunteer stipends, and mobile phone airtime.

Specific research techniques

These questions lend themselves to exploration through a case study of one AIDS-affected village, tracing flows of resources from village users to regional, national and global influences. This eclectic research approach is influenced by political ecology studies of local environmental change (Stonich 1993; Paulson and Gezon 2005), participatory rural research among farmers (Chambers 1997), rapid poverty assessments (Murphy 1998), global ethnographies to emphasize local/global networks (Burawoy et al 2000), and the actor-network approach (Latour 2005). A range of qualitative and quantitative methods will be used in an iterative, nested process: we start at village, work up and out to policy-level, then return to the village to share, interpret, assess and decide how to act on findings.

The case study approach is chosen over exclusive use of large-scale quantitative survey. The study tackles a fairly new topic for which little empirical information exists, and intensive methods allow freer exploration of issues that cannot be accommodated within a formal survey. Intensive methods also allow us to better appreciate the geographic, historical, social, political and economic influences that condition observable technology systems. Strict survey approaches also could not adequately attribute changes to HIV/AIDS, a topic which remains so sensitive that survey researchers use proxies (Donovan and Mather 2004). Prior fieldwork suggests that rural residents are eager to discuss the disease, and using proxies upholds the stigmatizing impression that HIV/AIDS indeed merits silence. This study will thus strike a balance, at times talking openly about HIV /AIDS (in local terms in private interviews) and other times, as in the household survey, using proxies to make people comfortable.

Village mapping is a participatory effort. The study site village was sketched in July 2005 with informants from the village (Fig 3). It indicates the boundaries, landmarks, farm plots, households, water sources, retail shops, school. Measures of HIV- and AIDS- affectedness were generated by local informants: HIV+, ill/bedridden, ART patient, death in household, came back to village to die, and household caring for orphans. The map and data will be updated as a first step in documenting village ownership and adaptation of the hoe and mobile, and discussion around innovative uses of both.

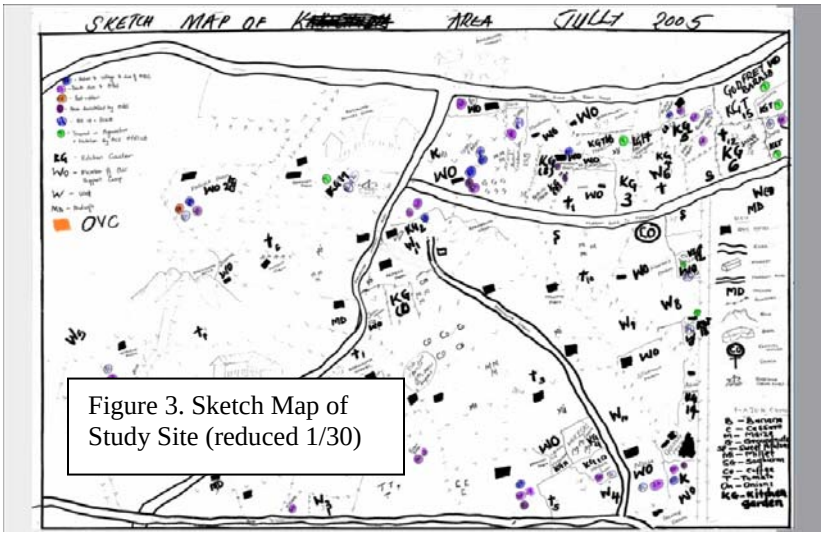

Figure 3. Sketch Map of Study Site (reduced 1/30)

A village census will document basic statistics on population, livelihoods, land, tools, infrastructure, and HIV and AIDS-affectedness. A team will administer a modest questionnaire (4-5 pages with simple tables, space for sketching the household farm, and many closed questions) to households with any presence in the village. These data will assess the degree of diffusion of, the range of uses for the hoe and mobile, and characteristics of a range of users. These data will reveal different types of technology non-use: i.e. partial

adoption, lack of exposure, outright rejection. Data will capture the range of HIV/AIDS-affectedness through standard proxy measures used by other larger surveys aiming to capture the impact of HIV/AIDS: i.e., "death of adult in the past year", "chronically-ill person in the household" (Donovan and Mather 2004, Mather et al 2004).

In-depth **individual interviews** with about 8-10 different "users" (i.e. innovators, early adopters to and "laggards" and non-users) will reveal motivations, resources, timing of adoption, applications, adaptations, problems. Individuals and specific topics to raise would be identified through village mapping, survey and focus group discussions. Transcription (translation, and reverse translation) of in-depth interviews will verify the text which is critical to individual narratives of technology use. These will also be used to identify topics for additional group discussions and other interviews, and will be shared back with respondents for further clarification.

Focus group discussions (FGD) with distinct categories of local users (and non-users) will reveal common problems, perceptions of technologies, terminology and other attitudes and norms. These will be conducted in the local language (Luhya), transcribed, and translated. One general FGD will be held before the village survey to help refine categories of "users" and help phrase specific questions. Additional FGD will be conducted after the survey to explore themes, verify conclusions, and determine further data collection. FGD will likely target groups of elderly women, youth groups (aged 15-30), rural entrepreneurs and peri-urban traders, persons living with HIV/AIDS. About 10 FGD are envisioned.

Key informant interviews: About 35-50 interviews with specific policy actors in government, NGO and private sector will shed light on telecommunications, agriculture/horticulture, and the HIV/AIDS policies and programs relevant to village phenomena. These individuals will be contacted in person, by phone, or email (in Nairobi, India, Finland, the US, or UK).

Additional techniques include **document review** of official policy statements and reports on farm extension programs, national food security policy, HIV/AIDS policy and programs, farm implements manufacture and imports, and the ICT sector. Sources include district documentation centers, NGOs, ministry offices, libraries, and the Kenya National Archives. **Participant observation** involves actually using the hoe & mobile for real tasks in the village (for composting; for text messaging and voice); attendance at farmer field schools, chiefs' meetings ("barazas"), and social marketing campaigns. Some **photo documentation** (digital stills, with some short digital video) will be necessary to illustrate specific technologies and how they are used, marketed, and sold.

Analysis

The case study data will directly address the research questions starting from the perspective of local users, and moving on to other actors, including suppliers, and NGO influences, up to the policy arena, as well as detailing the devices (i.e., different hoes and handsets/providers). Narratives of individual uses will anchor the study, accompanied by graphical representation of the village and networks of flows.

Users are individual men and women farmers of different ages, rural entrepreneurs, phone charger shops, members of women's groups, bicycle taxi drivers, community activists, and local leaders. These are subscribers and owners, innovators (creating new applications), partial users (who borrow a hoe and/or rent a mobile phone), and non-users. They span a continuum of HIV/AIDS –affected. Choices during the study about who to include and analyze (esp. for time-consuming in-depth interviews) will emphasize the lowest economic strata, heavily affected, and innovative applications.

Suppliers include actors such as local agricultural supply shops and phone charging outfits, up to national cellphone providers and international handset manufacturers (i.e., Motorola). This category includes aid agency projects who supply resources and even implements through their programs.

Policy actors include: local government officials, legislators (MPs), and development agencies, and analysis will identify specific external resources and influences for agriculture, manufacturing, HIV/AIDS prevention and support, and ICT.

Specific techniques for analysis of qualitative data include: text analysis of transcripts to reveal key themes in conversations with subjects; chronological timelines of significant events in group community and individual cases; and discussion of interim findings with informants to verify insights and key facts.

Triangulation of different sources of knowledge will reveal different interpretations of events, inadequacies in communication, and failures to implement policies and plans, drawing from multiple sources of field data. Inspection and interrogation of policy statements, project proposals, and agency reports which furthermore describe activities which might have affected local decisions and uptake: i.e., rural electrification, expansion of internet service, cellphone tower construction, training in conservation tillage, new ART or home-based care programs, etc.

Village census data will be used for simple frequencies and cross-tabulations of data at the level of the household, for the entire village: documenting data such as "number of households who have ever used a mobile phone", "current subscribers," those who "own a new hoe" and many other indicators of diffusion and variation. Simple cross-sectional multivariate analyses will help characterize this variation within the village using techniques such as probit (categorical) analysis of "adoption of mobile phone vs. /not-adoption" as a function of HIV/AIDS-affectedness, access to HIV/AIDS agencies, socio-economic status, and other variables. This effort will be a complement to the qualitative data and help illustrate village-level tendencies, identify participants in networks, provide details to enhance the village map, and provide a baseline for long-term study of change in the village.

Merit, Qualifications, and Relation to Other Work

The proposed PI combines extensive field experience on three continents over two decades with academic interests in technology and society, the social impact of HIV/AIDS, and rural development. After undergraduate training (Engineering and "Values, Technology, and Society") she served (from 1983-) as a VIA "Appropriate Technology" volunteer in Indonesia and in Kenya supporting small self-help projects She then returned to the US for doctoral training on population, environment, and development interactions, studying the political ecology of tropical deforestation. Her relevant research methods span participatory field methods, to rapid poverty assessment to quantitative surveys. The proposed study grew out of work in Kenya since 2003 on the implications of HIV/AIDS for rural livelihoods and for the work of aid agencies. Several articles and a book are coming out of this study (funded by the MacArthur Foundation). which solicited numerous examples of community-based technology change across sub-Saharan Africa, from agriculture to water to ICT, to help combat the HIV/AIDS epidemic.

The intellectual merit of the proposed study derives from its diverse scholarly influences and unique setting in rural Africa, which is unusual among STS studies. The proposed study takes off where the MacArthur project finishes, delving into depth in one location to explore, document and elaborate the theoretical and practical implications of rural hybrid technology systems. The study will contribute grounded, yet theoretically informed and institutionally objective insights which complement the applied

research of specific implementing agencies (i.e. of the FAO) and the academic focus on Western settings. The focus on understudied poor rural people and technologies will help advance our understanding of the heterogeneous network of rural technology change in a context of severe deprivations and extraordinary external influences.

The study is also expected to have larger social impacts, as it will enrich teaching of public health professionals at TU and in Kenya, enhance future research, and help improve development agency practice in rural Africa. This expectation builds on the PI's record of innovations in graduate teaching and experience in web-based scholarly communication.

Specifically, the study findings and village itself will be incorporated into a field course for graduate students in international health at Tulane University, who are in large majority female, and include African, Latin American, and Asian nationals. (The course is "INHL 653: Health and Development in Kenya in the age of HIV and AIDS": three credits, four weeks). The Kenya course itinerary and curriculum will be updated so students learn through visiting and speaking with villagers. The findings and techniques will also be integrated into classroom lectures. The study also helps train and build capacity of the research assistant and will promote collaboration among Kenyan social scientists working across sectors, from rural development, to HIV/AIDS, to ICT. To this end, the project will include a small "face-to-face" (not virtual) workshop for a few Kenyan scientists and project participants towards the end of fieldword. Reports and scholarly publications will be disseminated online and because broadband internet is limited even in Nairobi, outside of a few main centers, through CD –ROM.

As coordinator of the innovative virtual Population Environment Research Network (www.populationenvironmentresearch.org) founded in 2000, the proposed PI gained experience in populating, managing, promoting and disseminating electronic databases of scholarly research, and coordinating and hosting virtual "cyberseminars" for participants around the globe on topics such as urbanization and climate change. This experience highlights the potential yet real limitations of internet to promote international scientific networks and build capacity of developing country researchers. Furthermore, practical experience using different mobile phone providers and applications (and constraints) noted earlier in this proposal derive from using Nokia, Samsung and Motorola handsets, and both CelTel and Safaricom networks to run the 2004 & 2005 Kenya field courses and coordinate research in Nairobi, Bungoma, and Nyanza. For reaching colleagues outside of the UN center and major offices in the capital, the cellphone actually works better and is cheaper for basic communication than hard-wired internet.

The qualitative analysis and the survey data findings and interpretation will also help in the design of larger-scale surveys that are needed to gather and correctly model and interpret more widely generalizable data for the district or national level in Kenya, and possible other East African nations. This small exercise thus recognizes and builds on other large-scale, policy-relevant survey research in several African countries that attempts to properly attribute changes to AIDS, to understand the nature of the epidemic for African societies (Mather and Donovan 2004; Mather et al 2004).

Finally, broader social impacts arise from potential policy applications. How do hybrid technologies enhance human development? How do they deny access to some? What are pertinent government and agency policies--import taxes, local corruption in the distribution of funds, neglectful implementation of stated plans?