Traditional Knowledge, Use Practices and Conservation of Medicinal Plants for HIV/AIDS Care in Rural Tanzania

Daniel P. Kisangau, Thora Martina Herrmann, Herbert V. M. Lyaruu, Ken M Hosea, Cosam C. Joseph, Zakaria. H. Mbwambo and Pax J. Masimba

Research

Abstract

HIV/AIDS pandemic is currently the most socio-economic challenge that faces Tanzania as it affects mostly the young and most economically productive population. People living with HIV/AIDS in Tanzania are susceptible to fungal and bacterial opportunistic infections, which are a major cause of mortality and morbidity in the country. Despite the government's intervention to provide ARVs to people living with HIV/AIDS, many of them especially those living in the rural areas can neither afford them due to poverty nor access them due to distance to health centers. Moreover, resistance of opportunistic microbial pathogens to conventional medicines and the serious side effects associated with antiretroviral drugs are also a major drawback to the management of HIV/AIDS in the country. Due to these factors, many people opt to use of traditional medicines. This paper highlights the use and conservation of herbal remedies to manage HIV/AIDS pandemic in Tanzania. Ethnobotanical surveys were carried out in Bukoba Rural District to explore the traditional ethno-medical knowledge, the use and conservation of medicinal plants in the management of HIV/AIDS opportunistic infections and to determine whether levels of harvesting are sustainable. The district is currently an epicenter of HIV/AIDS and although over 90% of the population in the district relies on traditional medicines to manage the disease, this traditional knowledge still remains largely unknown. Seventy-five plant species belonging to 66 genera and 40 families were found to be used to treat one or more HIV/AIDS related diseases in the district. Eight plant species were tested *in-vitro* for their antifungal activity against three major fungal pathogens, *Candida albicans* (C.P. Robin) Berkhout, *Cryptococcus neoformans* (San Felice) Vuill., and *Aspergillus niger* Tiegh. Three of them were further tested *in-vivo* for their anti-*Candida* activity. With decreasing natural stocks of medicinal plants, and based on the results, this study further provides concrete recommendations for the conservation of these important non-timber forest products and the region's medicinal plant biodiversity.

Introduction

Human Immunodeficiency Virus (HIV)/ Acquired Immune Deficiency Syndrome (AIDS) is a major public health problem in many countries particularly those in sub-Saharan Africa. Hence in sub-Saharan Africa, traditional healers treat and manage a large number of people with HIV/

Correspondence

Daniel P. Kisangau, Department of Physical and Biological Sciences, South Eastern University College, P.O. Box 170-70200, Kitui, KENYA. kisangau@yahoo.com
Thora Martina Herrmann, Canada Research Chair in Ethnoecology and Biodiversity Conservation, Université de Montréal, CANADA. thora.martina.herrmann@umontreal.ca
Herbert V. M. Lyaruu, Department of Molecular Biology and Biotechnology, P.O. Box 35060, University of Dar es Salaam, Dar es Salaam, TANZANIA. lyaruu@amu.udsm.ac.tz
Ken M Hosea, Department of Botany, University of Dar es Salaam, PO Box 35060, Dar es Salaam, TANZANIA. hosea@amu.udsm.ac.tz
Cosam C. Joseph, Department of Chemistry, University of Dar es Salaam, P.O. Box 35061, Dar es Salaam, TANZANIA. cosam@chem.udsm.ac.tz
Zakaria. H. Mbwambo, Institute of Traditional Medicine, Muhimbili University of Health and Allied Sciences, P.O Box 65001, Dar Es Salaam, TANZANIA. zmbwambo@muhas.ac.tz
Pax J. Masimba, Department of Medical Parasitology and Infectious Biology, Swiss Tropical Institute, Basel University, Socinstrasse 57, Ch-4002, Basel, SWITZERLAND. paxjmasimba@yahoo.co.uk

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AIDS. Health facilities are overburdened by the increasing demand for care of HIV/AIDS patients (Uiso *et al*. 2006). The traditional healers play a crucial role of providing primary health care by taking care of people living with HIV/AIDS (Kala *et al*. 2004, Scheinman 2002). In 2006, almost two thirds (63%) of all persons infected with HIV/AIDS in the world were living in sub-Saharan Africa (UNAIDS/WHO 2006). HIV/AIDS pandemic is currently the largest socio-economic challenge that faces Tanzania as it affects mostly the young and most economically productive population (TACAIDS *et al*. 2005). This translates to loss of skills, talents, expertise and man-hours. The majority of the people living with HIV/AIDS are susceptible to fungal and bacterial opportunistic infections that result from immunosuppression (Kisangau *et al*. 2007). These infections have been reported from the early days of the HIV/AIDS pandemic and are one of the leading causes of deaths in Tanzania and worldwide (NIMR 2004). The use of plants as medicine is common to many cultures, and a number of advanced pharmaceutical drugs were derived from plants (NIH 1994). Worldwide, phytomedicines are more than salient features of ethnomedical systems; they are integral to the primary health care of 80% of people in developing countries where they are relied upon by 75% of people living with HIV/AIDS (WHO 2002). According to researchers, herbs help in management of AIDS cases due to their historical ability to: increase appetite, gain weight, stop diarrhea, reduce fever, clear up oral thrush, and resolve skin rash and fungus and treat herpes zoster.

Like in most other resource poor countries, Tanzania lacks well-established care for patients, such as provision of antiretrovirals (ARVs) and drugs for the treatment of opportunistic infections. More than 60% of the population in Tanzania depends on traditional medicines for the management of various diseases including HIV/AIDS (Mhame *et al*. 2004). Due to scarcity of drugs, poverty, high cost of life-enhancing drugs, resistance to conventional medicine and the serious side effects associated with antiretroviral drugs many people living with HIV/AIDS in Tanzania opt for traditional health services for the control of the disease. Traditional medicines are the most widely established and available health care system in Tanzania and it has been the effective low cost remedies to treat opportunistic infection associated with HIV/AIDS. The ratio of Medical Doctors to population in Tanzania is 1:20,000, while traditional healers are estimated at 1:350 (Kornel 2009)

The role of Traditional healers in managing HIV/AIDS

Traditional healers (THs) treating HIV/AIDS often outnumber doctors by 100 to 1 or more in Tanzania (Kornel 2009). They provide a large accessible, available and affordable trained human resource pool. THs provide client-centered, personalized indigenous health care that is culturally appropriate, holistic, and tailored to meet the needs and expectations of the patient. THs are culturally close to the clients, which facilitates communication about disease and related social issues. This is especially important in the case of STDs. Often THs are generally respected health care providers and leaders in their communities, and thus are treating large numbers of people living with HIV/AIDS. Healers have greater credibility than village health workers especially with respect to social and spiritual matters.

Existing health services are unaffordable by the poor, thus THs offer opportunities for reaching the poor at little added cost. They can be very powerful educators about HIV/AIDS to their clients and can play an important role in counselling the communities among which they practice. The importance of THs and the reliance on medicinal plants is more manifest in rural areas, as modern healthcare systems are more limited and even declining, whilst the environment facilitates the access and use of medicinal plants.

Traditional healers hold knowledge and experience on a wide range of medicinal plants that are useful to address a variety of AIDS-related health issues and problems. In particular, they highlight herbal treatments relevant for skin diseases, respiratory infections, diarrheal disorders, mouth problems, fever, loss of appetite, and weakness, among others.

Role of medicinal plants in combating HIV/AIDS

Medicinal plant diversity and the associated indigenous healthcare knowledge provide locally available and affordable means to address a wide range of health concerns related to HIV/AIDS, particularly as follows:

1. Herbal treatments to heal sexually transmitted diseases, thus reducing the risks of HIV infection and re-infection.
2. Herbal treatments to support immune strength and sustain an overall health well-being, thus serving to control the progression of HIV infection and to mitigate the potential impact of opportunistic diseases.
3. Herbal treatments to raise appetite, since loss of appetite is a frequent problem in AIDS patients that causes a downward cycle of malnutrition, weakness, and sickness.
4. Herbal treatments to address a number of HIV/AIDS associated and opportunistic diseases, such as respiratory infections, diarrheal diseases, and skin problems.

Community based initiatives dealing with HIV/AIDS management in Tanzania

Despite wide spread use of herbal medicines in managing HIV/AIDS related conditions in Tanzania, very few organized initiatives are available that deal with the management of the pandemic at community level using plant therapies. The most outstanding one is the Tanga AIDS Working Group (TAWG), a non-profit organization located on Tanzania's east coast. TAWG works to reduce HIV transmission and to assist people living with AIDS through health education, counseling and testing services and

home-based care—all done in collaboration with traditional healers. TAWG has so far treated 4,500 AIDS patients with opportunistic infection with herbal medicines. Currently it has over 1,300 patients from six treatment centers and also is building capacity of traditional healers to assess patients' progress (UNAIDS 2002). The organization aims to provide effective low cost herbal remedies to treat opportunistic infection associated with HIV/AIDS, conduct research on promising herbs and to ensure sustainable supply of medicinal plants in use through conservation and cultivation of the herbal medicinal plants.

Institutional-based initiatives

Traditional medicine received a boost in Africa when the continent's Heads of State meeting in Abuja in April 2001 declared that research into traditional medicine should be made a priority. Their declaration was followed up by another, in Lusaka in July 2001 designating the period 2001 - 2010 as the Decade of African Traditional Medicine. The development and adoption of the African Regional Strategy was complemented by the launch, in 2002, of the first global strategy on Traditional Medicine by WHO (Magola 2008). In Tanzania, gaps that exist between THs and biomedical scientists in health research have been addressed through recognition of THs among stakeholders in the country`s health sector as stipulated in the National Health Policy, the Policy and Act of Traditional, complementary and alternative medicine (Moshi 2005). The priority institution mandated with research and development of traditional medicine in the country is the Institute of Traditional Medicine (ITM), a constituent institute of Muhimbili University of Health and Allied Sciences (MUHAS).

Research status

A number of scientific articles have been published concerning the use of herbal medicines used to manage HIV/AIDS related conditions in Tanzania. An ethnomedical survey of Coast, Dar es Salaam, Morogoro and Tanga regions of Tanzania resulted in the identification of 36 plant species belonging to 21 plant families that are used traditionally for the treatment of *Candida* infections that are an important sign of HIV/AIDS (Runyoro *et al*. 2006). Some of the plants were reported to be active against other fungi including *Cryptococcus neoformans* (San Felice) Vuill., a major pathogenic fungus in HIV/AIDS. A study on knowledge of 132 traditional healers on HIV/AIDS in Arusha, Tanzania, revealed that 61% of the interviewed healers claimed to be treating HIV/AIDS patients (Uiso *et al*. 2006). Hamza *et al*. (2006) screened 65 methanolic plant extracts against *Candida* spp., *C. neoformans* and *Aspergillus niger* Tiegh., 40% of which were found to be active against one or more of the test fungi, hence confirming their traditional uses in the treatment of HIV/AIDS related conditions caused by these pathogens.

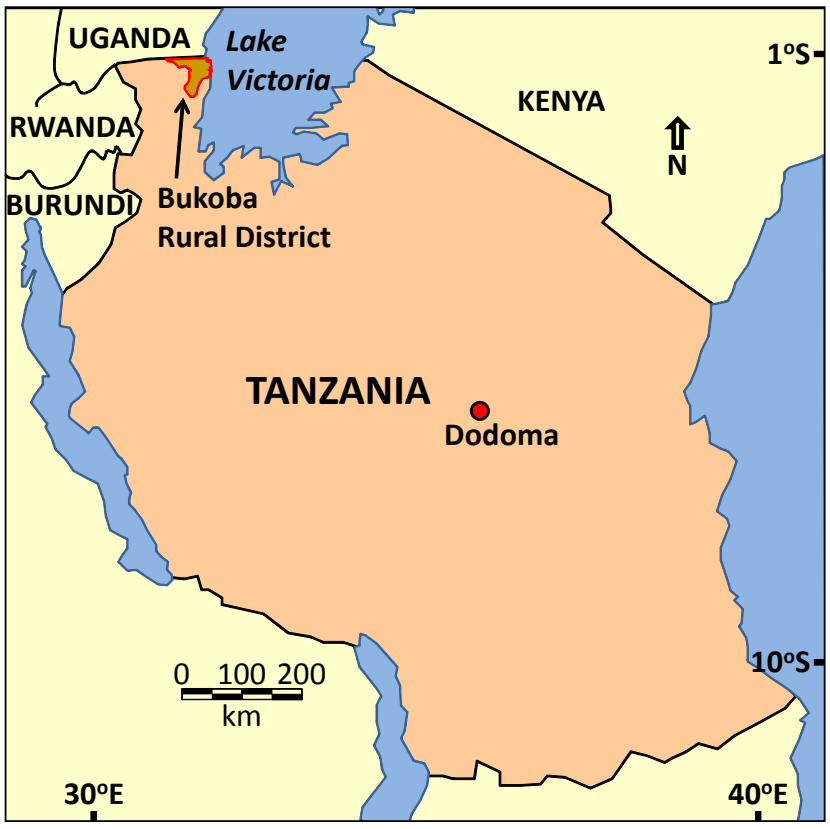

Figure 1. Bukoba rural district of Tanzania.

Methods and Materials

The study area

Bukoba Rural District is one of the six administrative districts in the Kagera region in north western Tanzania (Figure 1). The region borders Uganda to the North, Burundi and Rwanda to the West, and Lake Victoria to the East. There are 168 villages in 41 wards and 6 divisions within Bukoba District, which comprises a total population of 395,130 inhabitants (TUROT 2003).

The district is predominantly occupied by the indigenous Haya tribe whose native language is Kihaya. In 1991 the Haya population was estimated to number 1,200,000 (Appiah & Gates 1999). Agriculture is the economic mainstay of the district and accounts for 50% of the Region's Gross Domestic Product (GDP). The main crops are green

bananas, coffee, beans, cotton and cassava. Other crops include sugarcane, sweet potatoes, vegetables, millet and sorghum (TUROT 2003). The population:doctor ratio stands at 95,000:1, the lowest of all the six districts in Kagera region (TACAIDS 2005, TUROT 2003), indicating a severe inadequacy of health personnel.

Ethnobotanical surveys

Ethnobotanical surveys were carried out in 2007 in four out of the six divisions in the district: Kiamtwara, Misenye, Katerero and Rubale. With Prior Informed Consent (PIC), authentic and well known herbal practitioners were identified through a Participatory Rural Appraisal (PRA) approach, with the assistance of local administrative officers and health workers. Healers gave informed consent to the interviews, and respondents signed Material Transfer Forms (MTF) for purposes of intellectual property rights. They were then interviewed using semi-structured open-ended questionnaires (Martin 1995) (Figure 2). A total of thirty herbal practitioners aged between 32 and 80 years of age were interviewed during the study. Twenty-two out of the thirty respondents (73%) were above 50 years of age. Twenty-one (70%) of these were women and only nine were men. The majority of the respondents were peasant farmers and non-formally educated. Interviews were conducted in the local Kihaya language except for a few cases where the respondents were erudite and could understand Kiswahili. Information regarding the parts used, preparation, administration and the disease condition treated was documented.

Figure 2. An oral interview with a traditional herbalist on a market day in Bukoba Rural District, Tanzania. Many of these herbal preparations are used for managing HIV/AIDS related conditions. (Photo by Daniel Kisangau)

Field excursions were carried out with the help of traditional herbalists. Plant materials were collected and voucher specimens were coded and deposited at the Botany Department, herbarium (DSM), University of Dar es Salaam. All collected voucher specimens were identified by Mr. Suleiman Haji and Mr. Frank Mbago of the University of Dar es Salaam, Botany Department. Information based on personal observations was also recorded.

Knowledge on HIV/AIDS opportunistic infections

During the interviews, the symptoms of various HIV/AIDS opportunistic infections were described to the healers so as to enable them give the appropriate plant species they usually use to manage the infections (ATS 1990, Kauffman 2007, Simmers 2003, UNAIDS/WHO 2006). The Opportunistic infections considered in the present study were Tuberculosis (TB) locally called **Ndwala enkuri**, Oral candidiasis (**Mbunya kanua**), Cryptococcal meningitis (**Mulalamo**), Herpes zoster [Shingles] and Herpes simplex [Genital herpes] (**Ebiere**). The symptomatic conditions, skin rashes and chronic diarrhoea are locally called **Ubwere** and **Kuaruka** respectively.

Bioassays

Following the ethnobotanical surveys, *in-vitro* antifungal activity tests were carried out on dichloromethane extracts of eight of most promising plant species against major HIV/AIDS opportunistic fungal pathogens *Candida albicans* (C.P. Robin) Berkhout, *C. neoformans*, and *A. niger* using agar well and disc diffusion methods. The eight plant species screened are shown in Table 1 highlighted in green.

Out of these eight plant species, three of them (*Capparis erythrocarpos* Isert, *Dracaena steudneri* Engl. and *Sapium ellipticum* (Hochst.) Pax) were further analyzed *in-vivo* using an antifungal mice infection model. In this case, White Albino mice aged between 5 to 6 months and weighing between 20 to 30 g were randomized into five groups of 10 in separate cages. The five groups were immunosuppressed with 200 mg/kg body weight of cyclophosmamide for four consecutive days after which they were administered with 0.3 ml of 0.5 McFarland standard inoculum of *C. albicans*. Twenty four hours post infection, three groups were respectively treated with oral doses of 100, 200 and 400 mg/kg of body weight of the dichloromethane extracts using a gage needle. The fourth group, taken as positive control was intraperitoneally treated with fluconazole (Pfzer Ltd. S. Africa) at 10 mg/kg. Treatment of the four groups was given twice daily for

Table 1. Plant species used in treating various HIV/AIDS related conditions in Bukoba Rural District, Tanzania. Species that have become rare due to over-exploitation are marked with an * at the beginning of the row. Plant parts are: B-bark, F-fruit, L-leaves, R-roots, Se-seeds, St-stems, Sts-stem string, WP-whole plant. Promising species screened for antifungal activity are marked in green.

	Family **Scientific name** *over-exploitation	**Haya name**	**Parts used**	**HIV/AIDS related diseases treated**										**Collection code No.**
				Chronic cough	**Chronic diarrhea**	**Cryptococcal meningitis**	**Herpes simplex**	**Herpes zoster**	**Oral candidiasis**	**Oral sores**	**Skin infections**	**Skin rashes**	**Tuberculosis**	
Acanthaceae														
	Thunbergia alata Bojer ex Sims	**Rwankura**	L/R						X					DK013/06
Amaranthaceae														
	Chenopodium ambrosioides L.	**Akaita malogo**	L			X	X							DK056/06
	Chenopodium opulifolium Schrad. ex W.D.J. Koch & Ziz	**Mwitango**	L				X							DK015/06
Anacardiaceae														
*	*Lannea schimperi* (Hochst. ex A. Rich.) Engl.	**Ombumbo**	B		X		X	X				X	X	DK047/06
	Mangifera indica L.	**Omunembe**	L										X	DK037/06
	Ozoroa insignis Delile	**Omukerenge**	R			X	X	X	X				X	DK023/06
*	*Pseudospondias microcarpa* (A. Rich.) Engl.	**Omuziru**	L/B						X				X	DK005/06
	Rhus natalensis Bernh.	**Omusheshe**	L/R			X	X	X			X			DK044/06
	Rhus vulgaris Meikle	**Omukanja**	L/R		X						X			DK036/06
Annonaceae														
	Annona senegalensis Pers.	**Omukonya**	R			X		X			X			DK034/06
Apocynaceae														
*	*Rauvolfia vomitoria* Afzel.	**Omunyabusindi**	L/B/R				X	X				X		DK030/06
Araliaceae														
*	*Cussonia arborea* Hochst. ex A. Rich.	**Kijagaajaga**	B		X									DK022/06
Asparagaceae														
	Dracaena steudneri Engl.	**Omugorogoro**	B			X			X				X	DK014/06
Asphodelaceae														
	Aloe sp.	**Enkaka**	L					X						DK046/06
Asteraceae														
	Ageratum conyzoides L.	**Kyabakiriao**	L			X		X						DK025/06

Family Scientific name *over-exploitation	Haya name	Parts used	HIV/AIDS related diseases treated										Collection code No.
			Chronic cough	Chronic diarrhea	Cryptococcal meningitis	Herpes simplex	Herpes zoster	Oral candidiasis	Oral sores	Skin infections	Skin rashes	Tuberculosis	
Bidens pilosa L.	**Mbukurura**	L						X					DK054/06
Conyza floribunda Kunth	**Lukobe**	L									X		DK027/06
Senecio syringifolius O. Hoffm.	**Ekishenda**	R				X							DK031/06
Vernonia adoensis Sch. Bip. ex Walp.	**Nyakibasi**	L										X	DK008/06
Vernonia amygdalina Delile	**Omumbilizi**	L		X	X	X	X				X		DK016/06
Bignonaceae													
* *Kigelia africana* (Lam.) Benth.	**Omujunguti**	B/F				X							DK032/06
Capparaceae													
Capparis erythrocarpos Isert	**Oluvuranganga**	R		X	X	X	X	X			X	X	DK028/06
Capparis tomentosa Lam.	**Omukolokomba/ Rukwatango**	R				X	X	X				X	DK020/06
Gynandropsis gynandra (L.) Briq.	**Eiopyo**	L						X	X				DK033/06
Caricaceae													
Carica papaya L. (male)	-	L/R						X					DK035/06
Celastraceae													
* *Maytenus senegalensis* (Lam.) Exell	**Omunyambuliko**	B/R				X	X	X			X	X	DK018/06
Chrysobalanaceae													
* *Parinari curatellifolia* Planch. ex Benth.	**Omunazi**	B/R		X	X	X	X				X	X	DK039/06
Clusiaceae													
* *Garcinia buchananii* Baker	**Omusharazi**	B/R		X	X	X	X				X	X	DK063/06
Combretaceae													
* *Combretum collinum* Fresen.	**Omukoyoyo**	L/B/R		X								X	DK041/06
Terminalia mollis M.A. Lawson	**Muhongora**	B			X							X	DK058/06
Convolvulaceae													
Ipomoea sinensis (Desr.) Choisy	**Omusinda nyungu**	L						X				X	DK055/06

Family Scientific name *over-exploitation	Haya name	Parts used	HIV/AIDS related diseases treated										Collection code No.
			Chronic cough	Chronic diarrhea	Cryptococcal meningitis	Herpes simplex	Herpes zoster	Oral candidiasis	Oral sores	Skin infections	Skin rashes	Tuberculosis	
Cucurbitaceae													
Zehneria scabra (L.f.) Sond.	**Akabindizi**	WP			X	X		X			X		DK017/06
Dennstaedtiaceae													
Pteridium aquilinum (L.) Kuhn.	**Olulele**	L						X				X	DK029/06
Euphorbiaceae													
Jatropha curcas L.	**Ekiyo**	L						X			X		DK011/06
Ricinus communis L.	**Omujuna**	R	X										DK048/06
* *Sapium ellipticum* (Hochst.) Pax	**Omushasha**	B			X		X					X	DK019/06
Fabaceae													
Abrus precatorius L.	**Kaligaligo**	L						X					DK052/06
* *Acacia hockii* De Wild.	**Mugando**	B					X						DK038/06
Cajanus cajan (L.) Huth	**Mtandaikwa**	Sts						X					DK066/06
Cassia abbreviata Oliv.	**-**	L									X		DK045/06
Cassia mimosoides L.	**Akashanganziru**	L/R										X	DK024/06
* *Entada abyssinica* Steud. ex A. Rich.	**Mwiganjura**	L/B				X	X	X			X	X	DK026/06
Entada leptostachya Harms	**Ekitakuli**	R				X	X				X	X	DK043/06
* *Erythrina abyssinica* Lam.	**Omurinzi**	B/R										X	DK040/06
Eriosema psoraloides (Lam.) G. Don	**Omukakara**	L		X									DK077/06
Senna occidentalis (L.) Link	**Mwita njoka**	R		X									DK021/06
Hypericaceae													
Harungana madagascariensis Lam. ex Poir.	**Omujumbo**	L/R		X									DK006/06
* *Psorospermum febrifugum* Spach.	**Ekiana**	B/R			X	X	X			X			DK003/06
Lamiaceae													
Ocimum gratissimum L.	**Kashwagara**	L		X		X							DK065/06
Plectranthus barbatus Andrews	**Kasindano/ Kishwija**	L				X	X	X			X		DK010/06

Family Scientific name *over-exploitation		Haya name	Parts used	HIV/AIDS related diseases treated										Collection code No.
				Chronic cough	Chronic diarrhea	Cryptococcal meningitis	Herpes simplex	Herpes zoster	Oral candidiasis	Oral sores	Skin infections	Skin rashes	Tuberculosis	
	Plectranthus comosus Sims	**Mukono wa nkanda**	L				X	X	X			X	X	DK071/06
Malvaceae														
	Hibiscus fuscus Garcke	**Olushuya**	L		X									DK053/06
Myricaceae														
	Grewia bicolor Juss.	**Omukoma**	L/B/R		X									DK064/06
*	*Myrica salicifolia* Hochst. ex A. Rich.	**Omukikimbo**	B/R		X	X	X						X	DK057/06
Myrtaceae														
	Psidium guajava L.	**Omupera**	L		X								X	DK042/06
*	*Syzygium cordatum* Hochst.	**Omugege**	L/B				X	X				X		DK070/06
*	*Syzygium guineense* (Willd.) DC.	**Omuchwezi**	B		X									DK059/06
Olacaceae														
*	*Ximenia americana* L. var. *caffra* (Sond.) Engl.	**Omusheka**	R									X		DK074/06
Papaveraceae														
	Argemone mexicana L.	**Akatojo**	L/Se			X								DK062/06
Passifloraceae														
*	*Adenia gummifera* (Harv.) Harms	**Nyarimari**	St/R						X					DK073/06
Phyllanthaceae														
	Antidesma venosum E. Mey. ex Tul.	**Mbatabata**	R		X				X				X	DK049/06
	Phyllanthus reticulatus Poir.	**Kaumura**	L				X							DK076/06
Phytolacaceae														
	Phytolacca dodecandra L'Hér.	**Muhoko**	L					X				X		DK079/06
Polygalaceae														
*	*Securidaca longipedunculata* Fresen.	**Omweiya**	L/B/R			X			X					DK069/06
Polygonaceae														
	Rumex usambarensis (Engl. ex Dammer) Dammer	**Akarurinzi**	L/R		X				X		X			DK060/06

Family Scientific name *over-exploitation		Haya name	Parts used	HIV/AIDS related diseases treated										Collection code No.
				Chronic cough	Chronic diarrhea	Cryptococcal meningitis	Herpes simplex	Herpes zoster	Oral candidiasis	Oral sores	Skin infections	Skin rashes	Tuberculosis	
Ranunculaceae														
	Clematis hirsuta Guill. & Perr.	**Omnkamba**	L			X		X					X	DK051/06
Rubiaceae														
*	*Canthium zanzibaricum* Klotzsch	**Omushangati**	B/R			X								DK080/06
*	*Tarenna graveolens* (S. Moore) Bremek.	**Omushangati**	B/R			X								DK067/06
	Vangueria infausta Burch.	**Mubungo**	L			X								DK061/06
Rutaceae														
	Citrus limon (L.) Osbeck	-	R										X	DK075/06
Sapindaceae														
	Allophylus africanus P. Beauv.	**Katatera Mnyanya**	L		X									DK050/06
Ulmaceae														
	Trema orientalis (L.) Blume	**Muuwe**	L						X					DK078/06
Verbenaceae														
	Vitex fischeri Gürke	**Omuunda**	B				X	X				X	X	DK068/06
Vitaceae														
	Rhoicissus tridentata (L.f.) Wild & R.B. Drumm.	**Ekimara**	L					X						DK072/06

six consecutive days. The fifth group, taken as negative control was left untreated for six consecutive days post infection. Efficacy assessment of the plant extracts was done by sacrificing all surviving mice on day 11 post-infection, and then determining the geometric colony count per organ homogenate in the lungs, liver, brain and kidneys.

Results and Discussion

The role of medicinal plants used to manage HIV/AIDS

It was found that most informants could unambiguously and easily characterize symptoms of the targeted HIV/AIDS opportunistic infections. During the study, 75 plant species in 66 genera and 40 families were known to be used to treat one or more of the reported HIV/AIDS related diseases in the district (Table 1). Species from the families Anacardiaceae, Asteraceae, Capparaceae, Clusiaceae, Euphorbiaceae, Fabaceae, Rubiaceae, Myrtaceae, and Lamiaceae were the most frequently recorded (they constituted 52% of all the reported plant species), with each family having three or more species associated with the treatment of the opportunistic infections documented. The highest number of plant species used to treat the various conditions was recorded for TB which had 27 of the 75 documented species (Figure 3). Thirty-five of the 75 plant species were used to manage only one of the seven opportunistic infections reported, 39 were used to manage 2-6 of the conditions, while one plant species only, *C. erythrocarpos* was used to treat all the seven reported disease conditions (cf. also Kisangau *et al*. 2007). Eight of the nine plant species tested (highlighted in green in Table 1) were known to be particularly promising in treating the major HIV/AIDS opportunistic fungal pathogens *C. albicans*, *C. neoformans*, and *A. niger*.

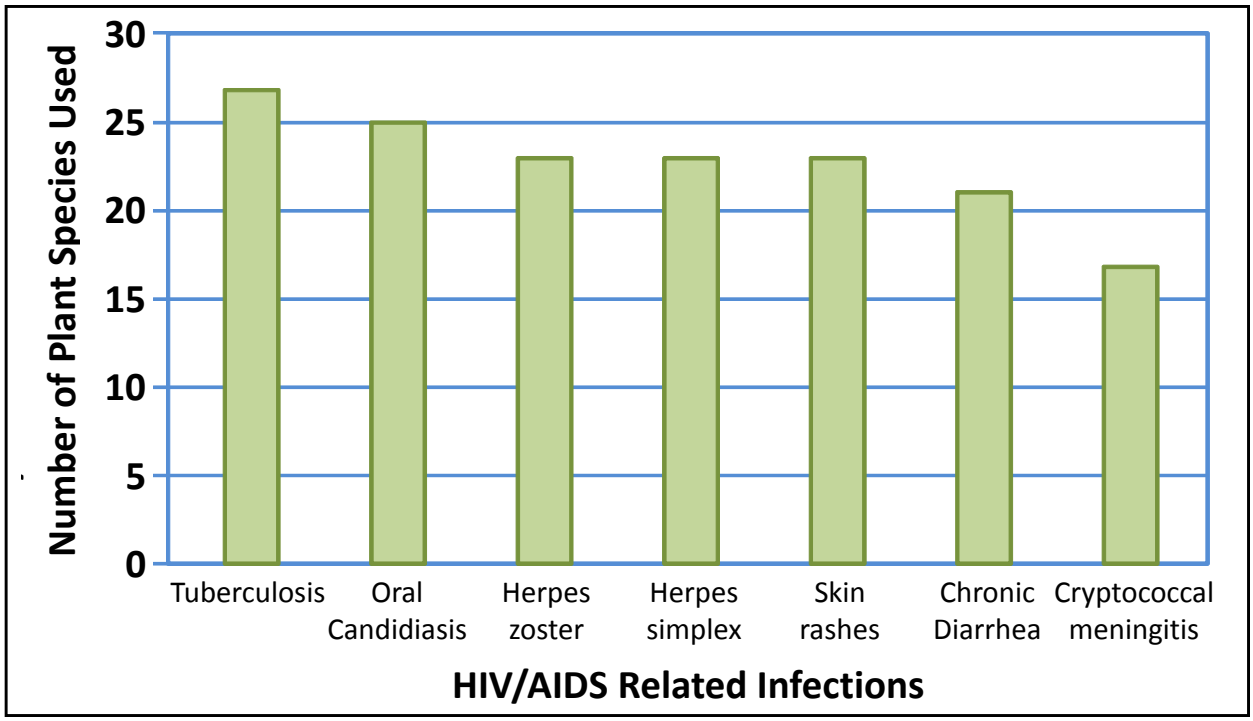

Figure 3. Comparison of number of plants used for different HIV/AIDS related conditions being treated in Bukoba Rural District, Tanzania.

The herbal medicines were mainly prepared using five methods: boiling, drying in sun and pulverization (Figure 4) soaking in cold water, burning, chewing (Figure 5). The most common method used was oral application of decoctions or infusions, especially for diseases like TB, Herpes zoster, Herpes simplex and Cryptococcal meningitis. Powdered medicines were mixed with jelly and applied as ointments for skin eruptions. Alternatively, decoctions or infusions were bathed with for the skin infections. Licking was especially employed for oral infections like oral candidiasis.

Figure 4. Traditional preparation of herbal medicines in Bukoba Rural District, Tanzania. (Photo by Daniel Kisangau)

With respect to the parts of the plants that are used, leaves were the most frequently used plant part in preparing herbal remedies, followed by roots, the bark or stem and other parts of plants like fruits or seeds (Figure 6).

The eight promising plant species identified in Table 1 yielded positive results with each being active against one or more of test fungal species. The *in-vivo* tests showed a substantial dose dependency in all the treatments administered. *Dracaena steudneri* and *C. erythrocarpos* revealed substantial activity against *C. albicans* compared to *S. ellipticum* with colony burden clearance reaching to more than

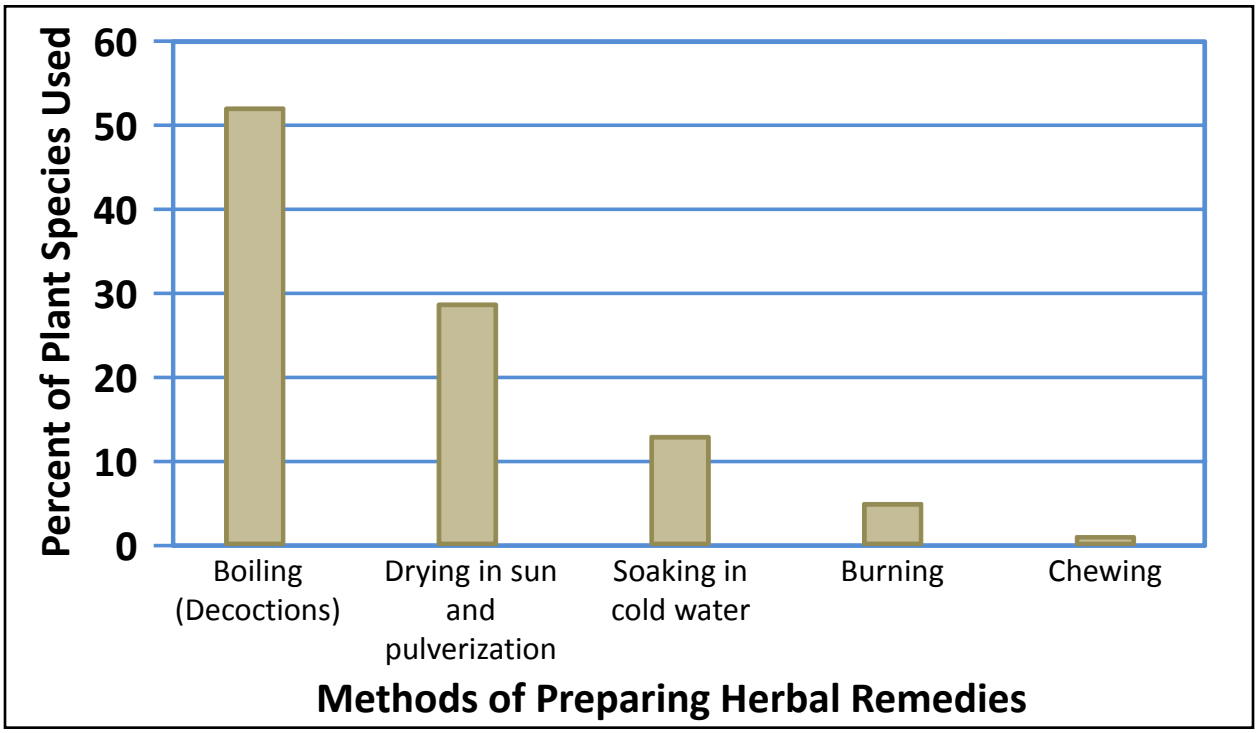

Figure 5. Methods of preparing herbal remedies (by percent of plant species used) for HIV/AIDS related conditions being treated in Bukoba Rural District, Tanzania.

90% in most treatments. The laboratory results clearly support the traditional uses of these plant species in managing HIV/AIDS opportunistic infections associated with these pathogens.

Traditional ethno-medical knowledge to manage HIV/AIDS, and its transmission

73% of the traditional herbal practitioners interviewed during the study were aged above 50 years. Thus, the majority of healers from whom a great deal of ethno-medical knowledge is derived are elderly. This puts the art of herbal medicine and indigenous health care knowledge at risk because as the older people die, so does their legacy of the use of traditional medicines to manage HIV/AIDS related infections (Kokwaro 1993, Sofowora 1982) if quick efforts are not exerted to document this invaluable knowledge.

Thus, there is a persistent gap in knowledge of herbal practice between the younger and older generations. Nevertheless, the older practitioners

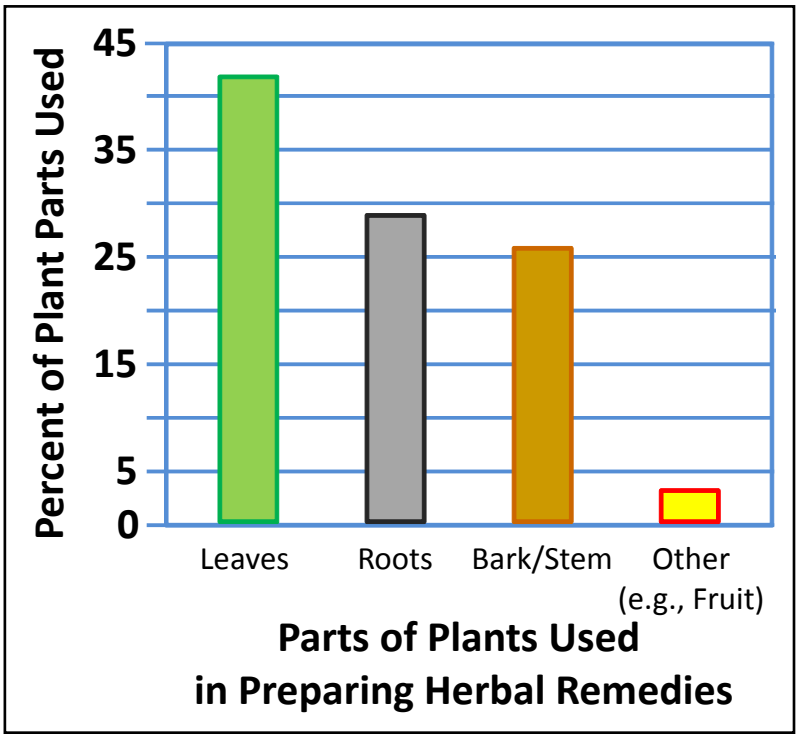

Figure 6. Parts of plants used in preparing herbal remedies (by percent of plant part used) for HIV/AIDS related conditions being treated in Bukoba Rural District, Tanzania.

are recognized by the local community as being competent to provide healthcare, using plant, animal and mineral substances, based on the social and cultural background of the local society (UNAIDS 2002).

Medicinal plant gathering and its impact on biodiversity

Field research in this study has shown that most of the plants used in traditional healthcare are collected from the wild, and only a few have been domesticated. Field observations, further revealed that the medicinal plants harvested from the wild were being over-exploited. Unregulated and poor harvesting methods were among the most important factors found to contribute to over exploitation and decreasing availability of medicinal plant resources. The most destructive methods of collection employed by the practitioners, as well as other community members, were: ring-barking or total debarking; uprooting of whole plants; and cutting whole plants. During the field research, trees of *Cussonia arborea* Hochst. ex A. Rich. and *Parinari curatellifolia* Planch. ex Benth. were found dead in different sites in Bukoba District, due to poor harvesting of the bark (i.e., total debarking) (Figure 7a,b).

In addition to unregulated and poor harvesting methods, other causes of over-exploitation of medicinal plants were identified in the study area:

- Forest clearance for agriculture and settlement;
- Uncontrolled burning and livestock grazing;
- Competing resource uses, such as timber logging and commercial harvesting for export;
- Extraction for use in the pharmaceutical industry.

Such practices have decreased the supply of popular herbal medicines, while demand continues to grow. The decline was confirmed by the finding that the herbal practitioners now have to travel long distances to collect the same kind of plants they used to collect within the vicinity of their homesteads only a few years ago. Interviews with the practitioners revealed that medicinal plant gatherers are able to report which species are becoming difficult to find because of habitat destruction, over exploitation, or limited geographical distribution. Consequently, priority plant species in need of urgent conservation were determined: 22 medicinal plants can be classified as having become rare or threatened due to over-exploitation for medicinal purposes (cf. Table 1, plants becoming scarce are marked with an asterisk *).

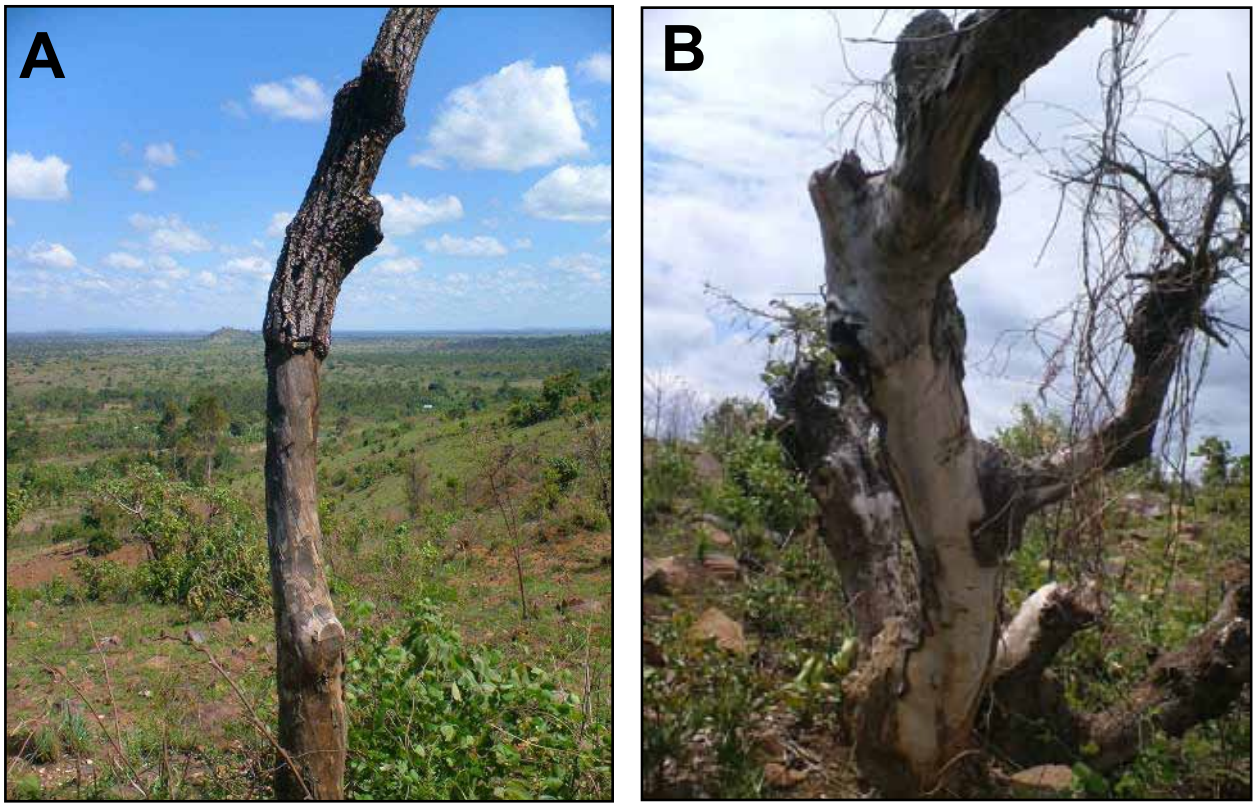

Figure 7. Poor harvesting of bark through total debarking in Bukoba Rural District, Tanzania. **A**. Dead *Cussonia arborea* Hochst. ex A. Rich. tree. **B**. Dead *Parinari curatellifolia* Planch. ex Benth. tree. (Photos by Daniel Kisangau)

With decreasing natural stocks of medicinal plants, traditional healers are now interested in sustainable management of these important non-timber forest products and conservation of the region's biodiversity. Some initiatives have been established by various organizations in Tanzania in order to conserve the increasingly rare and threatened medicinal plants in the country. Along with TAWG, other plant conservation initiatives include the African Rainforest Conservancy (ARC) which has been building grassroots village networks in the Eastern Arc Mountains of Tanzania through a participatory forest management program. The Program's aim is to empower villagers to participate in the protection of local resources including medicinal plants (Hobbs 2003, www.africarainforest.org). An ongoing tree domestication program is being implemented by the World Agroforestry Centre (ICRAF) in collaboration with partners in the central western Tanzania. The aim of the domestication process is to bring wild fruits and medicinal trees to the farm in order to ensure sustainable availability of the plants, enhance food security, and improve income, health and nutritional status of the poor rural and urban communities while safeguarding their biodiversity and protecting the environment (Mbwambo 2004). The Institute of Traditional Medicine (ITM) is also promoting community based cultivation of medicinal plants to serve the purpose of supplying raw materials for the production of herbal extracts and herbal medicines. This is also intended to promote national strategies for poverty reduction (Moshi 2005).

Conclusions and Recommendations

Ethnobotanical surveys revealed a diversity of medicinal plants used in the management of HIV/AIDS opportunistic infections by traditional Haya healers in Bukoba Rural District in Tanzania. HIV/AIDS opportunistic conditions considered during this study were Tuberculosis (TB), Herpes zoster (Shingles), Herpes simplex (Genital herpes), Oral candidiasis, Cryptococcal meningitis, skin rashes and chronic diarrhea. The positive laboratory results of *in-vitro* and *in-vivo* bioassays clearly support the effectiveness of ethno-medical knowledge and traditional uses of these plant species in managing HIV/AIDS opportunistic infections associated with major fungal species.

In the study area, with few exceptions, traditional medicinal plants are gathered from the wild. Most of these plant parts were harvested unsustainably without any consideration for future resource availability. For example, a major issue of concern is that bark and roots are harvested from most plants, which may indicate potentially high impacts on the long-term survival of the species. Concerns are likely to be magnified by the extensive commercial trade and sale of medicinal plant parts by market vendors. Consequently, some species are now highly threatened. This calls for urgent conservation measures. If the current, uncontrolled collection of medicinal plants is not regulated, many species will soon disappear from the wild. It is, therefore, of crucial importance to rural communities that information on the appropriate methods for cultivating medicinal plants is disseminated and that training is provided on sustainable harvesting methods.

Awareness campaigns on the importance of cultivating medicinal plants should be carried out at grassroots level. On-farm cultivation trials of identified priority species might be a viable way to ensure availability and sustainability of medicinal plant resources. However, plant cultivation by the practitioners may be constrained by the lack of appropriate technologies, as well as cultural beliefs. There is, therefore, a need to train the herbalists to use cheap and appropriate propagation techniques for medicinal plants so as to sustain supply.

As this study has shown, most of the herbal knowledge is held by the elderly traditional herbal practitioners, which implies that the legacy of the use of traditional medicines to manage HIV/AIDS related infections is in danger of being lost. We would therefore encourage the mobilization of herbal practitioners to form conservation groups, as this might be a positive step towards transmission of their wealth of traditional knowledge, and towards ensuring long-term conservation and sustainable use of medicinal plants.

Results of this study showed that traditional medicinal plants and indigenous healthcare knowledge represent a strategic force in healthcare action, capable of complementing modern healthcare systems. In addition, they are often the only healthcare option available or affordable in rural areas, as modern healthcare services are often missing, deficient or expensive. Accordingly, we would argue that the healthcare response to HIV/AIDS in rural Africa has much to benefit from the conservation, use and improvement of medicinal plants and herbal treatments. This requires mobilizing indigenous healthcare knowledge, empowering traditional healers, and fostering the cooperation between traditional and modern healthcare systems. We would also state that a collaboration between the agriculture (agrobiodiversity) and health sectors around medicinal plants is equally valuable to enhance the healthcare response to HIV/AIDS in rural communities of Africa.

In our view there is need to foster concerted efforts to promote establishment of community—based initiatives that will engage in medicinal plants cultivation, improvement of local herbal treatments, and support of traditional healers as a strategy to mitigate HIV/AIDS health impact. These concerted efforts should focus on three inter-related issues with a priority focus on the HIV/AIDS epidemic, as follows:

1. Medicinal plants: conservation, use and research.
2. Traditional healers: training, organizational aspects and empowerment.

3. Increased collaboration between traditional and modern health practitioners.

Based on the results of our study, we would suggest the following activities as a way forward to promote the use of herbal remedies and the involvement of traditional healers in increasing access to HIV/AIDS care and prevention in Tanzania :

- Promote the participatory elaboration of inventories of medicinal plants used to treat health problems related to HIV/AIDS. Compare the use of these resources across regions and cultures. Train healers to keep records of the use and effectiveness of selected medicinal plants.
- Establish partnerships with universities and research centers to conduct clinical studies on the effectiveness and properties of selected medicinal plants of relevance in key health problems, especially those related to HIV/AIDS.
- Create herbal gardens as spaces for conservation, demonstration, research and diffusion of medicinal plant resources. Promote home herbal gardens at the community level, supporting traditional healers and interested households in setting up these fields.
- Promote spaces for the dialogue and cooperation between traditional and modern health practitioners.
- Support and improve the healthcare role of traditional healers at community level, through training (from HIV/AIDS issues to improved traditional healthcare), creating associations of traditional healers, conducting actions to enhance the collaboration with modern doctors in the fight against HIV/AIDS, and encouraging spaces for transmission and for critical exchange of knowledge related to medicinal plants.
- Promote community education on the value and limitations of medicinal plants and traditional herbal treatments, generating critical thinking at the community level to foster the use of medicinal plants but also to reduce unsustainable harvesting.
- Promote meetings and regional initiatives around medicinal plants and healthcare, in order to: (a) share inventories on medicinal plants that are used to address health problems related to HIV/AIDS, evaluating critically their effectiveness and means to further experiment and promote them; (b) share methodologies and results from clinical studies conducted on medicinal plants; and (c) share experiences on the mobilization of traditional healers and on the dialogue/cooperation between traditional and modern health practitioners in the fight against HIV/AIDS.

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