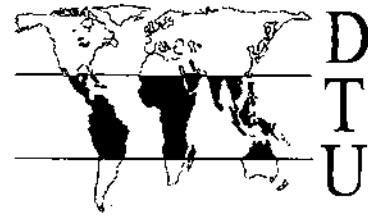


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Preliminary Study of Rainwater Harvesting in
Mid-West Uganda

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PRELIMINARY STUDY OF RAINWATER HARVESTING IN MID-WEST UGANDA

Results of a study undertaken by Dr Terry Thomas in collaboration with Uganda Rural Development Training Programme (URDT) in November 1995.

Introduction

Domestic rainwater harvesting is the collecting of run-off during rains from impermeable surfaces on houses or close to houses, its storage in waterproof vessels and its subsequent use as the water supply of the inhabitants of these houses. The use may be "temporary" (for example during the 24 hours following a rainstorm), "seasonal" (throughout the rainy season) or "permanent" (throughout the year except perhaps in years of exceptionally low rainfall). These three levels of use require in Western Uganda, storage capacities per household of around 80 litres, 1200 litres and 10000 litres respectively. In some places there are opportunities for collecting water from institutional roofs and the roofs of commercial buildings. As commercial buildings in the Target Areas are mostly small shops that also serve as dwellings, they may be regarded as included within 'domestic' rainwater sources.

The most suitable run-off surface in Western Uganda is the corrugated iron roof. Grass roofs are mostly of such loose construction and small size that neither the quality nor quantity of run-off from them is suitable. Grass roofs are also difficult to gutter. Tile roofs are rare in the Area; asbestos roofs are absent. Bare rock surfaces are rarely close to habitations, other ground surfaces give very contaminated and silt-laden run-off.

At present, over the whole area, the majority of the population is using water from contaminated and inconvenient sources, most commonly from waterholes in valleys below their houses. "Temporary" rainwater harvesting, as defined above, is widely practised: most households put out plastic or pottery containers under their roof during rains. However it is rare to find more than 50 litres of such collecting capacity per household. A few households have gutters and storage adequate for "seasonal" water supply, the storage is most commonly a cement jar of 1 to 2 cubic meters capacity. Larger tanks sized for "permanent" supply are rare; there are a few in Kabarole District for example next to dwellings on tea estates, and a few in Fort Portal and Hoima towns. These large tanks are commonly made of galvanised iron.

Roofs and Gutters

Because of the high rainfall, iron roofs are common in Western Uganda and their use is increasing following the national development in recent years. The Uganda National Integrated Household survey of 1992-3 indicated only 31% of households with iron roofs, however it is believed the current figure for Western Uganda is considerably higher.

A survey was undertaken in November 1995 within the 3 Districts. It is clear that the occurrence of iron roofs is strongly influenced by type of settlement.

In the two towns of Fort Portal and Hoima over 90% of buildings have iron roofs (auxiliary buildings like kitchens have not been counted).

Along roads of sufficient important to carry taxi/minibus services over 90% of buildings in trading posts have iron roofs and about 70% of isolated buildings close to those roads have them.

Scattered homesteads away from roads have a lower incidence of iron roofs. A number of villages were surveyed, the villages were selected as being at least 2km from significant roads. Very isolated villages were not surveyed but are believed to have very few iron roofs.

Table Survey of Roofing in Mid West Uganda

District	Location	Total homes	Iron roofs		% part gutters
			No	%	
Kabarole	Village near Bigodi	40	20	50	0
	Farms in Hakibale county	110	76	70	0
	4 villages (S of Kyenjojo, Mwenge Co.)	454	181	49	30
Kibaale	3 villages near Kagadi (Buyaga Co.)	195	117	60	10
	4 villages in Bwikara sub-county (Buyaga Co.)	394	236	60	50
	2 villages near Rabona (Buyaga Co.)	55	20	45	0
	Migrant settlement near Narweyo	80	5	<10	0
Hoima	3 villages E. of Hoima	220	145	66	6
Total		1548	800	52	

From this preliminary survey and assuming 25% of the population lives in towns or trading posts, the likely availability of iron roofs is 60% (computed as $0.25 \times 90\% + 0.75 \times 50\%$).

Full gutters are very rare and even partial guttering is uncommon in the Target Area; gutters are only installed for rainwater harvesting purposes. The normal roof overhang is intended to reduce soil erosion or splash damage due to un-guttered run-off but this is often ineffective. Trading posts in particular suffer from significant erosion due to roofwater run-off.

Gutters, where present, are usually of corrugated or folded galvanised iron suspended from the roof sheets themselves or from rafter ends. As eaves are low, guttering is often stabilised by props from the ground, for example 2 meter wooden poles. Plastic guttering supported by special brackets from barge boards (as is the European norm) is absent in Western Uganda. This may change with the current expansion of PVC product manufacture in Uganda.

Rainfall, Water Consumption and Storage Requirement

With the exception of a narrow rain shadow (generally under 2 km wide) along the shores of Lake Albert, the whole Target Area has a bimodal pattern of precipitation generally exceeding 1000 mm a year. Over 1200 mm a year reaches much of the Area and in places annual precipitation exceeds 2000 mm.

Taking 40 sq.m. as a minimum roof size, full guttering, 1000 mm rainfall, 85% rainwater capture and 8 persons per household gives an average daily capture of 12 litres per person. This is half the WHO recommended figure of 24 litres per person per day but about equal to current daily consumption of 5 jerrycans per large family.

Using the more typical 1200 mm rainfall and 50 sq.m. gives 18 liters per person per day. This is a considerable increase on current norms and on the levels recorded in East Africa long ago by Bradley and White for communities without piped water.

A recent study by Rugumayo of the Directorate of Water Development (Rugumayo AI, "Rainwater Harvesting in Uganda", a paper presented to the conference on *Sustainability of Water & Sanitation Systems*, Kampala, September 1995, proceedings to be published by WEDC, Loughborough, U.K.) showed a storage requirement of about 22% of annual consumption in bimodal rainfall areas of Uganda. This figure would be slightly reduced if the roof area were oversized for the consumption or if dry season consumption were lower than the annual average. The figure also varies with the level of drought-year security adopted; however it is generally uneconomic to provide sufficient storage to carry water over from wet years to dry ones.

On Rugumayo's evidence, storage for a family of 8 consuming 18 liters per capita per day would need to be around

$$8 \times 18 \times 365 \times .22 = 11,500 \text{ liters} = 11.5 \text{ cubic meters.}$$

It is expected that more detailed studies will indicate that 8 to 10 cubic meters is sufficient for most households.

The present cost of 10 cubic meters storage is too high for most households to afford. 1994 prices, collected by RUWASA for Eastern Uganda, indicated the cost of 10 cubic meters storage + fittings to be about

\$ 550	for concrete block tanks (with no cover?)
\$ 400	for corrugated iron tanks
\$2000	for HDPE plastic tanks.

Ferrocement tanks, cheaper than concrete block tanks in Kenya, are probably of similar cost to concrete block tanks in Uganda due to the very high price of steel mesh here. Concrete jars, as currently made in Western Uganda, would cost about \$900 to make up 10 cubic meters.

For comparison iron sheets for a typical roof cost \$200 to \$300.

It is an informed assumption of this proposal that there is scope for substantially reducing water storage costs in Western Uganda by taking advantage of local factors such as stable soil, low water table, cheap bricks etc. Storage costs dominate rainwater harvesting costs and

are therefore critically affect economic viability. An 8 cubic meter domed underground tank has just (December 1995) been built at the URDT Institute, Kagadi and a second is being excavated. Their materials cost is under \$100 each: their performance will be tested,

Water Supply Alternatives in Mid-Western Uganda

Excluding the two towns with pumped piped water (although the Fort Portal system is currently barely operational) the viable forms of supply in the Area are, in order of current usage:

- (i) waterholes, swamps and streams, not protected from contamination,
 - (ii) shallow wells in valley bottoms made hygienic with the aid of handpumps,
 - (iii) protected springs,
 - (iv) man-made reservoirs, with or without in-situ sand filtering of water,
 - (v) boreholes,
 - (vi) rainwater harvesting.
-
- (i) Unprotected surface sources give low quality water very cheaply at locations often far from homesteads and nearly always below them: water is carried uphill from them. There are possibilities of partially improving quality (fencing, filtering, pollution control) and convenience (carrying aids).
 - (ii) Hygienic shallow wells give good quality water at modest cost (e.g. \$100 per household) are therefore the basis of most current water improvement activities in the Target Area. Near trading posts the water extraction rate is often inadequate (due to low pump or aquifer flowrates) and long queues form. Location is rarely convenient and effort in water carriage is typically 100 minutes per household per day in addition to queuing time.
 - (iii) The high permeability of soil in the region results in generally low water-tables and low-level emergence of springs. Well defined spring "eyes" are relatively rare. Springs are normally lower than dwellings, thereby precluding gravity-fed reticulation. Spring protection is currently undertaken in Kibaale and Hoima districts, but good springs are not common enough to offer most communities water within 500 meters (a distance corresponding to the 100 minutes per day carriage time cited above).
 - (iv) Man-made tanks (i.e. reservoirs behind low dams) are applicable in the drier North East of the Target Area. They may be regarded as a variant on shallow wells, in that a shallow well with pump alongside a tank is the preferred method of hygienic water extraction. Their cost, coupled with the difficulty of minimising reservoir leakage in permeable ground, limits their application to areas where other methods do not work.
 - (v) The most difficult parts of the Target Area for water supply are those without the topology that permits shallow well construction. A number of boreholes have been expensively drilled in the Target Area. Most have proved difficult to maintain by their user communities and therefore failed during the collapse of centralised maintenance services in the 1970s. Modern designs and procedures (eg. VLOM) solve some of the problems and a few boreholes are being rehabilitated. For scattered

settlements it will always be costly to achieve convenient (i.e. very local) supply via boreholes. Moreover deep ground water in the Target Area is usually sufficiently high in iron content that treatment to remove it is desirable.

- (vi) Rainwater harvesting is therefore to be compared with the five alternatives above. Its performance is not yet fully known. Storm intensity (that affects gutter sizing), variability of precipitation and dry season length (which affect storage and roof area requirements) and other factors need more detailed local measurement.

Rainwater harvesting has the following advantages in the Area:

- gives very convenient supply, no walking required;
- is largely independent of outside organisation for construction and maintenance;
- gives fairly high water quality which may be further increased by simple means;
- reduces the area of roofing iron required, because of less overhang;
- reduces run-off erosion, especially in townships and urban areas.

It has the disadvantages of:

- rather high cost per household unless cheaper storage methods can be found;
- discrimination against the poor who have grass roofs and insufficient funds;
- storage structures being vulnerable to earth tremors to which the Area is subject;
- vulnerability to drought years.

Further Development of Rainwater Harvesting

Because a strong *prima facie case* can be made for rainwater harvesting in the Target Area yet current usage of the technique is very slight, there appears to be scope for

- (i) a programme of design development to reduce the cost of components of rainwater systems - in particular water storage tanks - and to optimize their sizing.
- (ii) field studies to identify why there is such an apparent mismatch between potential and actual usage of the technique.

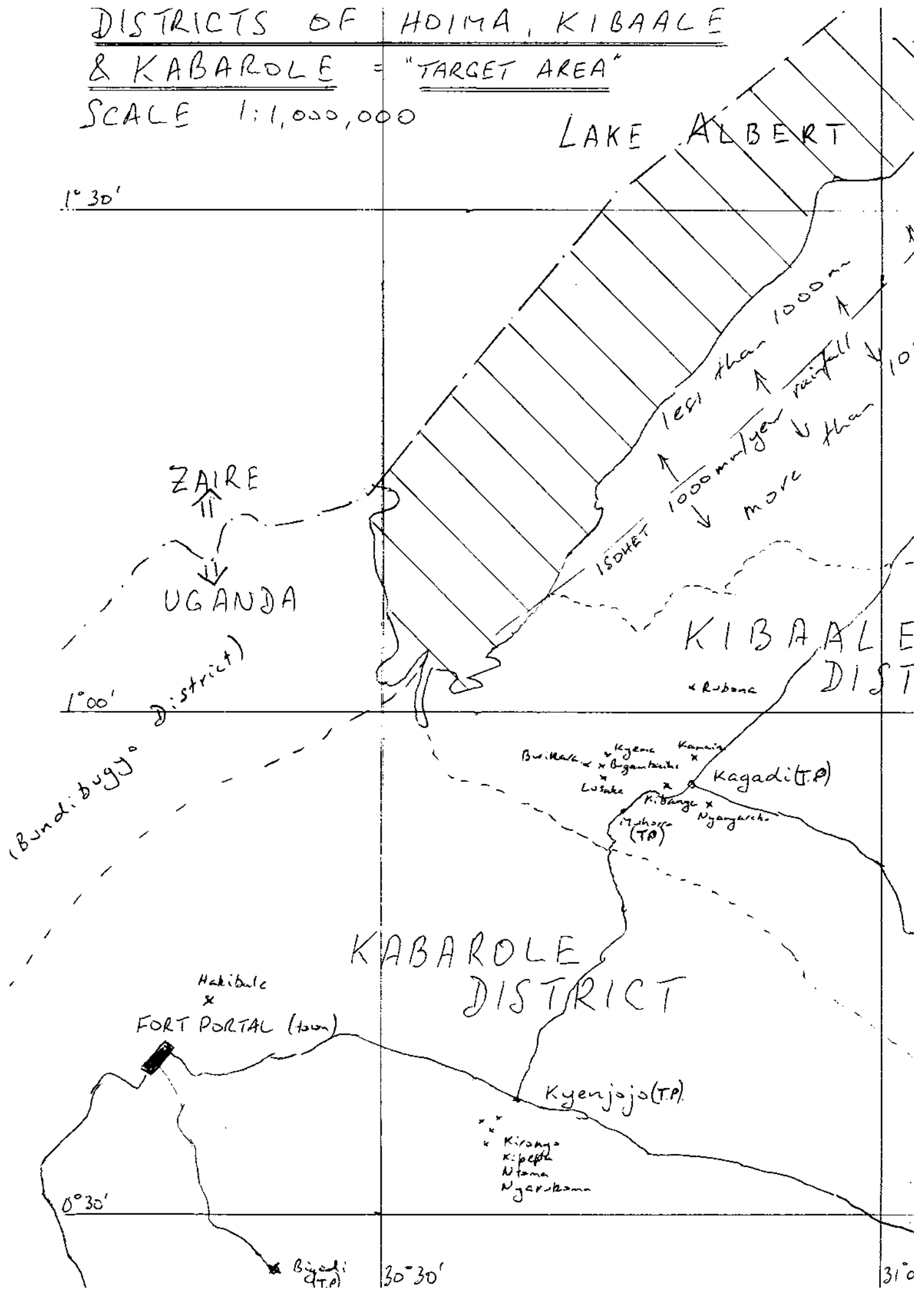
Map

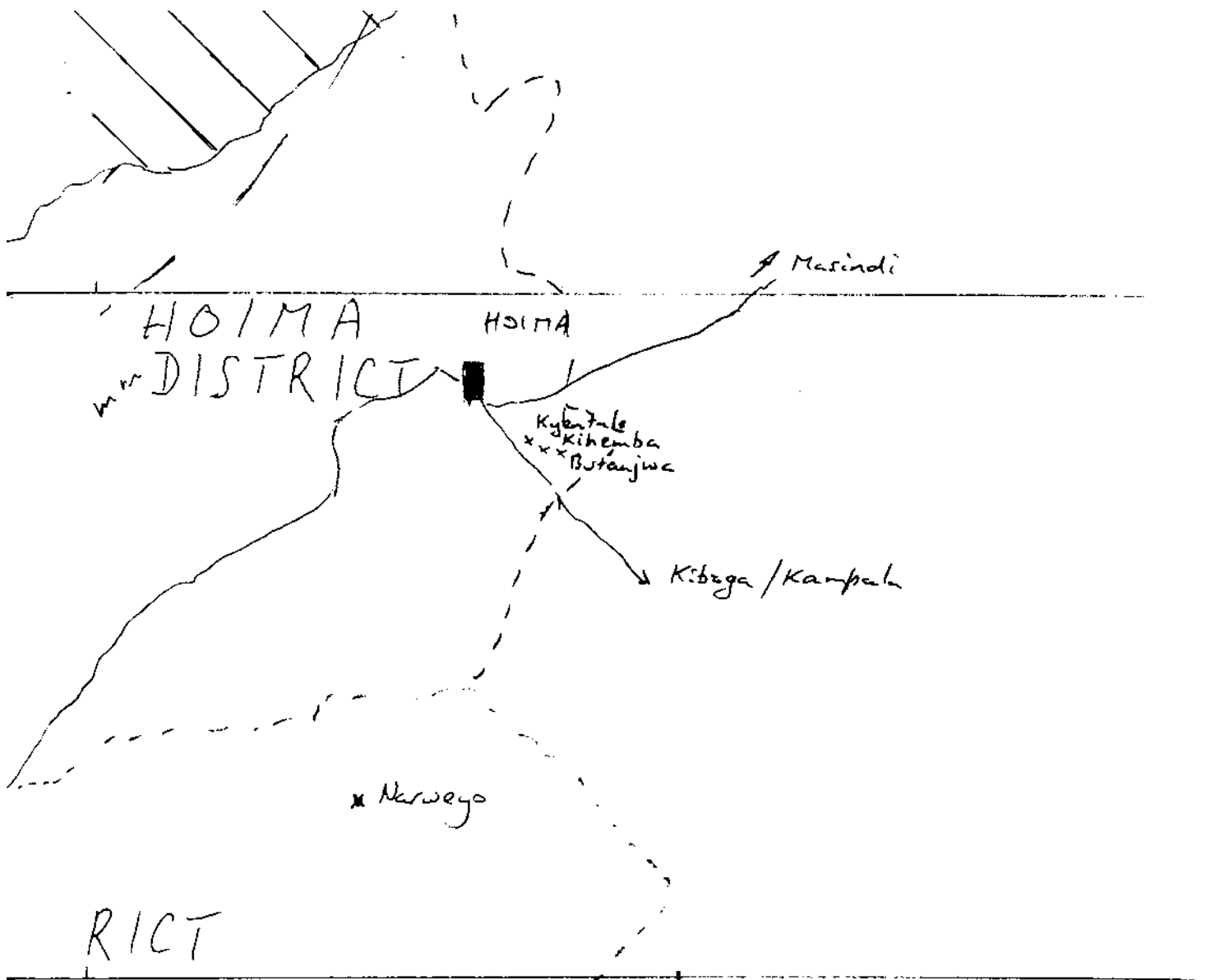
The map overleaf shows, Mid Western Uganda, which is made up of three districts: Hoima, Kibale and Kabarole and the location of the villages and roads surveyed for the presence of iron roofing. The total Target Area is about 15,000 sq'km. However other districts of Uganda, besides the three studied here, have rainfall and soil conditions that seem to favour rainwater harvesting. Much of Kiboga, Mubende, Mpigi, Masaka, Bushenyi, Kasese, Rukungiri, Kisoro and Kabale Districts appear suitable, as do parts of Mbarara, Masindi, Luweso, Ntungamo and Mukono Districts. Outside Uganda, large areas of Eastern Zaire and parts of Kagera Province in Tanzania show similar characteristics.

DISTRICTS OF HOIMA, KIBAALE

& KABAROLE = "TARGET AREA"

SCALE 1:1,000,000





KEY

x Village surveyed for type of roof

~ Road travelled observing roofing. (Main roads only)

■ Town

(TP) Large trading post
 ○ = very small town
 (Population exceeding 3000)

■ Kibacle (TP)

■ MUBENDE