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# A classification of the clones of East African Highland bananas (*Musa*) found in Uganda

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## Summary
**A classification of the clones of East African Highland bananas (*Musa*) found in Uganda**
The clones of East African Highland bananas in the Ugandan national collections and in farmers' fields in Uganda have been classified into five clone sets. Clone sets are considered to be a category above the level of clone or cultivar but below the level of cultivar group (the Highland bananas are a distinct subgroup within the cultivar group comprised by the AAA genome triploids). The five clone sets are described and a key to the clone sets is provided. This classification should aid those concerned with the conservation and utilization of germplasm of Ugandan Highland bananas. It now needs to be tested on Highland bananas from other East African countries.

**Key words:** Banana, classification, clones, *Musa*, Uganda

## Résumé
**Classification des clones de bananiers d'altitude d'Afrique orientale (*Musa*) observés en Ouganda**
Les clones de bananiers d'altitude d'Afrique orientale issus des collections nationales ougandaises et de champs d'agriculteurs ougandais ont été répartis en cinq ensembles. Ces ensembles de clones sont considérés comme une catégorie supérieure au clone ou au cultivar, mais située hiérarchiquement à un niveau inférieur au groupe de cultivars (les bananiers d'altitude constituent un sous-groupe distinct au sein du groupe de cultivars comprenant les triploïdes de génome AAA). Les cinq ensembles de clones sont décrits et une clé des ensembles de clones est proposée. Cette classification devrait aider les personnes soucieuses de la conservation et de l'utilisation du germoplasme des bananiers d'altitude ougandais. Elle doit à présent être évaluée en l'appliquant à des bananiers d'altitude d'autres pays d'Afrique orientale.

## Resumen
**Una clasificación de los clones de los bananos de montaña de Africa oriental (*Musa*) de Uganda**
Los clones de los bananos de montaña del África oriental existentes en las colecciones nacionales de Uganda y en los campos cultivados del país han sido clasificados en cinco conjuntos de clones. Los conjuntos de clones se consideran como una categoría por encima del clon o cultivar pero por debajo del grupo de cultivares (los bananos de montaña son un subgrupo distinto dentro del grupo de cultivares integrado por triploides de genoma AAA). Se describen los cinco conjuntos de clones y se les asigna una clave. Esta clasificación será útil para quienes se ocupan de la conservación y utilización de germoplasma de bananos de montaña de Uganda. Tendrá que ser cotejada con los bananos de montaña de otros países del Africa oriental.

## Introduction
Ugandans classify bananas into cooking bananas, beer bananas, roasting bananas and sweet or dessert bananas, according to their use. Cooking bananas are represented by more clones than any of the other groups. Like the familiar dessert bananas, the East African cooking bananas are triploids (genomic formula AAA), containing the A genome of diploid *Musa acuminata* (Shepherd 1957; Stover and Simmonds 1987). When fully ripe, they can be eaten raw like dessert bananas but as their pulp is insipid they are more usually eaten after cooking. They are known locally as matooke, which (with minor variants) is the word generally used for bananas in the various languages used within a broad corridor which goes from the highlands of Uganda to the Ruvuma valley near the coast of Tanzania (Wrigley 1989). The same word is used in Uganda for the thick yellow paste made from the cooked and mashed fruit, which is a major dish in most banana-growing areas of this country. In the East African Highlands an estimated 300 kg of bananas are consumed per person per year. This is more than anywhere else in the world (Swennen and Vuylsteke 1991).

Beer bananas are known locally as mbidde (in the Luganda language) or mbiire (in Luyankore/Lukiga). They have bitter astringent fruits which are unpalatable even when cooked, hence they are used only for making beer. Other bananas which have been introduced to Uganda relatively recently and which represent different genome groups within *Musa* are also used for making beer, for example Kisubi (an AB diploid with the B genome of *M. balbisiana*), and Kayinja and Kivuvu (both members of the Bluggoe subgroup of ABB triploids; Stover and Simmonds 1987).

The Highland bananas used for cooking and to make beer together form what Shepherd (1957) called the Lujugira-Mutika subgroup of the AAA genome group. As they thrive on the East African plateau at altitudes of 900-1800 m (Davies 1995), they are now more often known as the East African Highland bananas. There is much diversity within the Highland bananas in both morphological characters and characters related to the quality of the matooke or the beer made from their fruit. However, the Highland bananas as a whole are very susceptible to pests and diseases such as banana weevil (*Cosmopolites sordidus*), nematodes (particularly *Pratylenchus goodeyi* and *Radopholus similis*), black Sigatoka (*Mycosphaerella fijiensis*), fusarium wilt and various viruses (Gowen 1995; Jeger *et al.* 1995). Screening and breeding programmes to identify useful resistances and incorporate them in the crop have now commenced, but have been handicapped by the lack of any comprehensive classification of the numerous clones within the East African Highland bananas.

## Distinctive features of the East African Highland bananas

Table 1 shows the distinguishing characters of the principal groups of bananas found in Uganda. Most Highland bananas are easily recognized by the intense black or, less commonly, brown or bronze blotches which give the pseudostems a glossy appearance similar to polished metal. With the exception of Green Red, which also has a dark pseudostem, other bananas commonly found in Uganda have green or greenish-yellow pseudostems which either lack or have only faint blotches. Highland bananas have darker green leaves than most other bananas, though this difference is most easily observed at a distance of about 10 m from the plants. Kivuvu and Kidhozi, two ABB clones, also have dark green leaves but these are glossy, unlike the dull dark green leaves of the Highland bananas.

## Classification within the East African Highland bananas

A morphometric study (Karamura 1998) of accessions of East African Highland bananas in the two Ugandan national collections (at Kawanda Agricultural Research Institute and at Kabanyolo Agricultural Research Institute) shows that each clone could be assigned unambiguously to one of five groups of clones by classificatory discriminant analysis, even though these groups overlapped in both cluster analyses and principal component analysis. Clones studied in farmers' fields could also be assigned

**Table 1. Morphological differences between the groups of bananas found in Uganda[1]**

| Character | East African Highland (AAA) | Cavendish (AAA) | Gros Michel (AAA) | Green Red (AAA) | Kivuvu and Kidhozi (ABB) | Kayinja and Mussa (ABB) | Plantains (AAB) | Sukali Ndizi and Kisubi (AB) |
|---|---|---|---|---|---|---|---|---|
| **Pseudostem** | | | | | | | | |
| Colour of outermost sheath | medium green | green-yellow | green-yellow | red-purple | green-yellow | green-yellow | green-yellow with flushes of pink | green-yellow |
| Colour of sheath underlying outermost sheath | pink-purple | pink-purple | pink-purple | pink-purple | watery green | watery green | watery green | watery green |
| Blotches | black or brown | slight, brown | slight, brown | absent | absent | absent | slight, pink | slight, brown |
| **Leaf** | | | | | | | | |
| Petiole canal margins | spreading | spreading | spreading | spreading | overlapping | incurved | erect | incurved |
| Upper surface of leaf | dark green, dull | green | green | green-red | dark green, shiny | green | green | green |
| **Inflorescence** | | | | | | | | |
| Peduncle hairiness | coarsely hairy | coarsely hairy | coarsely hairy | coarsely hairy | glabrous | glabrous | glabrous | glabrous |
| **Bract** | | | | | | | | |
| Apex | acute to obtuse | intermediate | intermediate | intermediate | acute | acute | acute | acute |
| External face | purple-brown | red-purple | red-purple | purple-brown | pink-purple | pink-purple | pink-purple | blue-purple (Sukali Ndizi); red-purple (Kisubi) |
| Internal face | red fading to yellow at base | red fading to yellow at base | red fading to yellow at base | red fading to yellow at base | red throughout | red throughout | red throughout | red throughout |
| Shape | ovate to lanceolate | narrowly ovate | narrowly ovate | broadly ovate | lanceolate | lanceolate | lanceolate | narrowly lanceolate |
| Revolute/not | revolute | revolute | revolute | revolute | revolute | not revolute | not revolute | not revolute |
| **Male flower** | | | | | | | | |
| Compound tepal (excluding lobes) | cream | cream | cream | flushed with pink | flushed with pink | flushed with pink | flushed with pink | flushed with pink |
| Lobes of compound tepal | yellow | yellow | yellow | orange | orange | orange | orange | yellow |
| Anther colour | pink | orange | cream | cream | yellow | pink | cream | cream |
| Stigma colour | orange | orange | yellow | orange | cream | yellow | orange | orange |
| **Fruit** | | | | | | | | |
| Ovule rows per locule | 2 | 2 | 2 | 2 | 4 | 4 | 2 | 2 |
| Pedicel length | short (1.5 cm or less) to long (>1.5 cm) | long (>1.5 cm) | long (>1.5 cm) | short (1.5 cm or less) | long (>1.5 cm) | short (1.5 cm or less) | long (>1.5 cm) | short (1.5 cm or less) |

[1] For further information and standardized colour chart see Simmonds and Shepherd (1955) and IPGRI-INIBAP/CIRAD (1996).

**Table 2. Morphological differences between the clone sets of East African Highland bananas found in Uganda**

| Character | Mbidde | Nakitembe | Nakabululu | Musakala | Nfuuka |
|---|---|---|---|---|---|
| **Height** (m) | 2.5-4.5 | 1.9-5.5 | 1.5-3.5 or dwarf (<1.5) | 2.0-4.5, rarely semi-dwarf (<2.0) | 1.5-5.9 |
| **Pseudostem** | | | | | |
| Blotches | profuse, black | sparse, black | sparse (rarely profuse), black | sparse, black | sparse (absent in two clones), black (brown in one clone) |
| **Sap** | milky, sticky, drips rapidly on wounding | milky, less sticky, drips on wounding | milky, less sticky, drips on wounding | milky, less sticky, drips on wounding | usually milky, sticky, drips rapidly on wounding (colourless, does not drip rapidly in two clones) |
| **Suckers** | | | | | |
| Number | few | numerous | very numerous | few | usually very few (fairly abundant in a few clones) |
| Position | vertical | vertical | vertical | vertical (inclined in one clone) | vertical |
| Tubular leaves | present in some clones | absent | absent | absent | absent |
| **Adult leaves** | | | | | |
| Width (cm) | 35-85 | <75 | usually >75 | 60-85 | usually >85 |
| Tip | not twisted | not twisted | not twisted | curved or twisted | not twisted |
| **Bunch** | | | | | |
| Position | pendulous, oblique or subhorizontal | oblique to pendulous | subhorizontal | pendulous | subhorizontal to oblique (rarely pendulous) |
| Shape | usually rectangular to cylindrical | rectangular (sometimes cylindrical or truncated) | rounded | truncated, cylindrical or rectangular | rectangular or cylindrical |
| Appearance | lax, compact or very compact | lax to compact | very compact | lax | compact |
| **Rachis** | | | | | |
| Position | subhorizontal, oblique or pendulous | oblique | oblique | pendulous | oblique |
| Appearance | without remains of bracts or flowers | persistent or semi-persistent remains of flowers | usually no persistent remains of bracts or flowers (semi-persistent neuter flowers in two clones) | without remains of bracts or flowers | without remains of bracts or flowers |
| **Male bud** | | | | | |
| Shape | rounded, lanceolate, elliptical or cordate | elliptical or cordate | ovate | cordate, lanceolate or oblong | lanceolate or elliptical |
| Apex | pointed, intermediate or obtuse | pointed or intermediate | obtuse | pointed or intermediate | pointed or intermediate |
| Bract imbrication | imbricate or not | usually imbricate, occasionally not | not imbricate | not imbricate | not imbricate |
| Colour | purple-brown | purple-brown | purple-brown | purple-brown | purple-brown (green-yellow in a few clones) |
| **Fruit** | | | | | |
| Position | recurved or not | strongly recurved or not | not recurved | recurved | slightly recurved or not |
| Length (cm) | variable | 15-20 | <15 | >20 | 15-20 |
| Length:width ratio | 3.0-5.0 | 3.5-4.4 | <3.5 | >4.5 | 3.5-4.4 |
| Shape | usually inflated | rectangular to slender | rounded | slender | rectangular |
| Apex | blunt | intermediate to bottlenecked | intermediate or blunt | bottlenecked | blunt or intermediate |
| Style on fruit | persistent (then usually fleshy, but occasionally dry) or non-persistent | persistent; fleshy or dry | usually non-persistent | non-persistent | usually non-persistent; fleshy if persistent |
| Staminodes on fruit | persistent or not | persistent | usually non-persistent | non-persistent | usually non-persistent |
| Pulp colour | white (immature), cream (mature), sticky brown excretions when cut | white to cream (immature), orange-brown (mature), no sticky brown excretions | white to cream (immature), orange-brown (mature), no sticky brown excretions | white (immature), cream (mature), no sticky brown excretions | white (immature), cream or rarely orange-brown (mature), no sticky brown excretions |
| Flavour | bitter, astringent | insipid | insipid | insipid | insipid |

to these five groups. A report of this morphometric study is in preparation.

The International Code of Nomenclature for Cultivated Plants (Trehane *et al.* 1995) provides only one category, cultivar group, above the rank of cultivar. Clones of Highland bananas are generally considered to be cultivars. Simmonds (1959), and Stover and Simmonds (1987) treated the genome groups as cultivar groups and the East African Highland bananas as one of a number of subgroups within the AAA cultivar group. An additional category is needed to denote the groups of clones identified within the Highland bananas; we have chosen to call these clone sets.

## Key to clone sets of East African Highland bananas in Uganda

| | | |
|---|---|---|
| 1 | Pulp bitter and astringent, with sticky brown excretions | **Mbidde** |
| | Pulp insipid without sticky brown excretions | 2 |
| 2 | Male inflorescence rachis with persistent neuter flowers; male bud imbricate; style and sometimes staminodes persisting on fruit apices | **Nakitembe** |
| | Male inflorescence rachis naked or with semi-persistent neuter flowers; male bud not imbricate; style and staminodes usually not persisting on fruit apices | 3 |
| 3 | Bunch orientation subhorizontal; fruits <15 cm long with length/width ratio <3.5; male buds ovate | **Nakabululu** |
| | Bunch orientation oblique to pendulous; fruits >15 cm long with length/width ratio >3.5; male bud lanceolate, elliptical, cordate or obovate | 4 |
| 4 | Bunch shape mainly truncate or cylindrical, very lax; fruits slender with bottle-necked apices | **Musakala** |
| | Bunch shape mainly rectangular, compact; fruits inflated or rounded or rectangular with intermediate-shaped apices | **Nfuuka** |

Table 2 summarizes further distinctive features of each clone set.

## Names and relative importance of the five clone sets in Uganda

Local names have been adopted for each clone set. Mbidde means beer and this clone set (Fig. 1) contains 14 of the 84 clones recognized among the 238 accessions studied. Nakitembe (Fig. 2) means "like ekitembe". Ekitembe is the local name for ensete. Members of the Nakitembe clone set resemble ensete in that the bracts and floral parts of the male flowers persist on the rachis. The name nakitembe also relates to the Luganda word okutembuka which implies hurrying, i.e. maturing in a short time. We included a further 14 clones

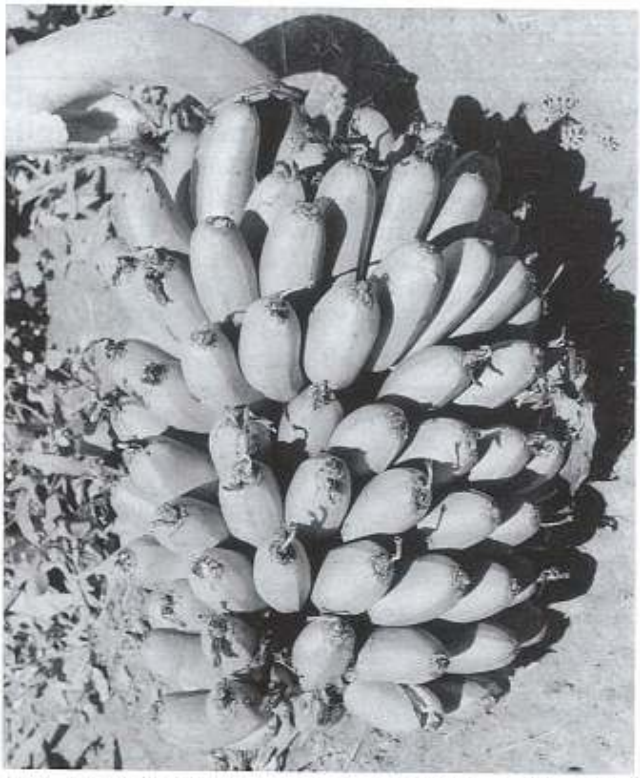

**Fig. 1.** Mdibbe (beer) clone set: clone Namadhi, showing the inflated fruits with blunt apices and persistent dry styles and staminodes.

**Fig. 2.** Nakitembe clone set: clone Mbwazirume (immature), showing the persistent style on fruits, the persistent neuter flowers along the male rachis and the imbricate male bud.

in this clone set. Nakabululu (Fig. 3) indicates short and compact bunches and fruits, but also means that all fruits in the bunch ripen simultaneously. Of the 84 clones recognized, 11 were placed in this clone set. Musakala (Fig. 4) means lax and refers to the lax bunches of this clone set, in which we placed nine clones. Nfuuka (Fig. 5) means "I am changing". This is a dynamic clone set with some morphologically unstable clones. It is the most heterogeneous of our five clone sets and also contains the most clones: 36 out of the total of 84.

## Conclusions

As more clones are studied in farmers' fields throughout Uganda, it may be necessary to redefine the clone sets and/or expand their number beyond the five recognized here. We have presented the results from our initial study so that this classification may be available to, and evaluated by, those working on Highland bananas in Uganda and other East African countries. It will be interesting to learn whether a classification that appears useful in Uganda will prove workable in neighbouring countries such as Rwanda and Burundi, where the proportion of beer in relation to cooking clones is higher than in Uganda, or in Tanzania, where some clones which are distinct from those in Uganda appear to exist.

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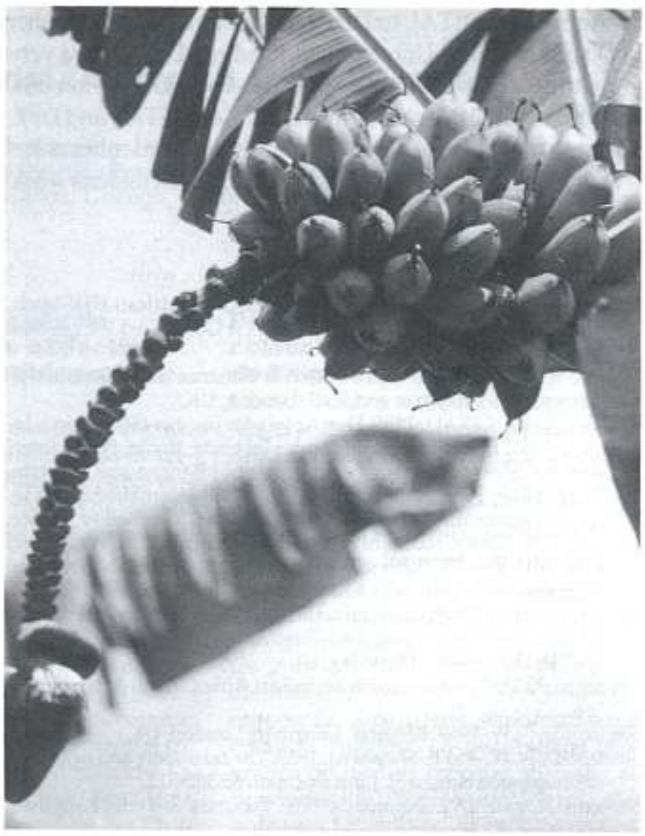

**Fig. 3.** Nakabululu clone set: clone Bifusi, showing the subhorizontal compact and short bunch of short, rounded fruits.

**Fig. 4.** Musakala clone set: clone Mudwale, showing the lax truncate bunch of long, slender and bottle-necked fruits.

**Fig. 5.** Nfuuka clone set: clone Enyeru, showing the oblique rectangular and compact bunch, with medium fruits not strongly recurved towards the rachis.

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