

Vegetable Production and Problems Involved therein in the Lake Kivu Area, Zaire

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I. Introduction

We chose two places located near the Lake Kivu in Zaire to study vegetable production, one being Kashenyi and the other, Bugobe Center (Fig. 1, Table 1). The population density is very high near the Lake Kivu because the soil and weather conditions are favorable for living there.

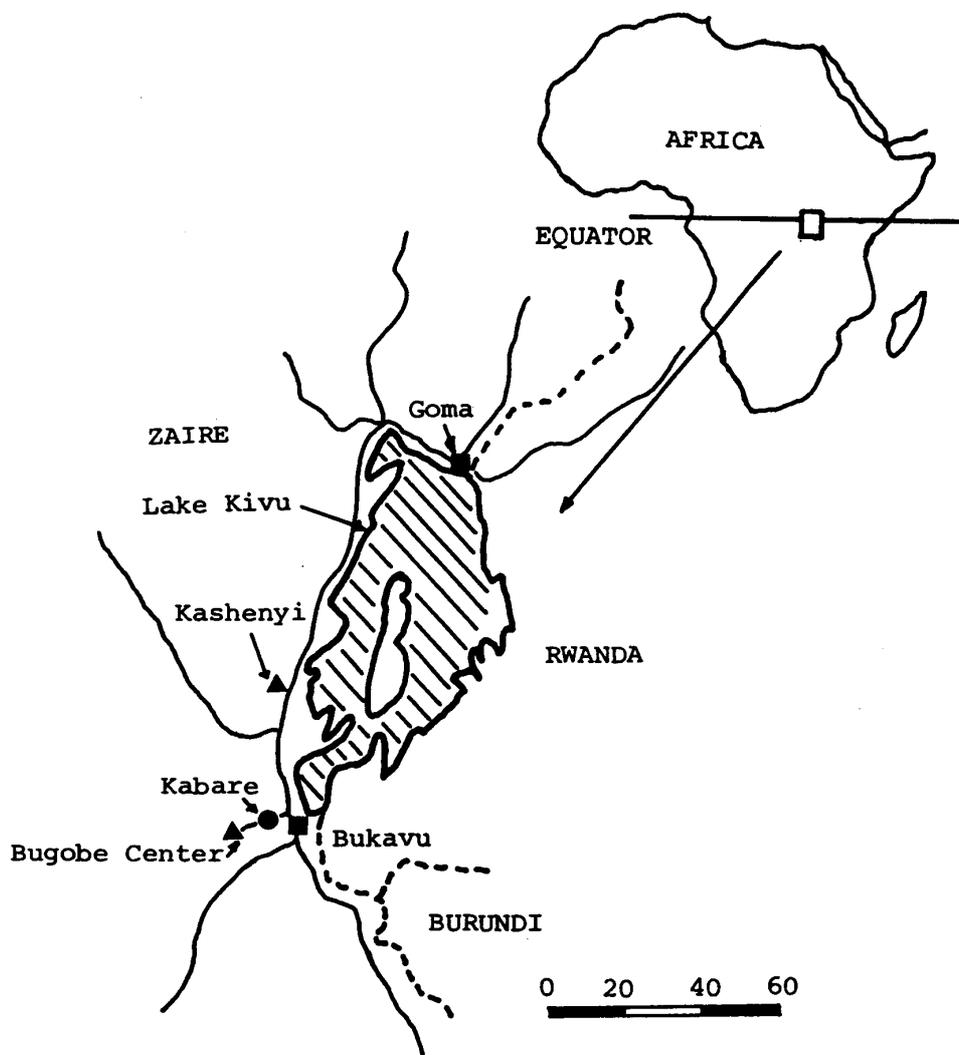


Fig. 1 Location of the study areas.

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Kashenyi, which faces the road from Bukavu to Goma, is located on comparatively flat land, and Bugobe Center is in a hilly area. The climatic conditions of the study areas (Table 1) were

Table 1. Locations and meteorological data of the study areas.

Station	Longitude E.	Latitude S.	Altitude (m)	Mean temperature (°C)	Annual rainfall (mm)
Goma	29° 14'	1° 41'	1, 515	19. 0	1, 108
Nyamakana ¹⁾	28° 48'	2° 18'	1, 700	17. 7	1, 336
Bukavu	28° 51'	2° 31'	1, 635	20. 0	1, 271
Kabare ²⁾	28° 43'	2° 30'	1, 975	15. 2	1, 323

Note: 1 and 2 are the meteorological stations nearest Kashenyi and Bugobe Center, respectively. Meteorological data are cited from Hecq's report (1958).

evaluated from information from the farmers and from Hecq's report (1958) ; recent meteorological data were not available. Both areas receive about 1, 300–1, 500 mm of rainfall annually. In general, precipitation is seasonal, with a rainy season with an early peak in October, and another peak in March, followed by a gradual decrease to a minimum in July. The mean temperature at Kashenyi and Bugobe Center were estimated to be about 17 °C and 15 °C, respectively, by using Hecq's data.

The whole of the region is on the brink of the rift valley and has undergone vigorous volcanic activities throughout the late Tertiary and Quaternary periods. Even today two volcanoes, Nyiragongo and Nyamulagira, to the north of the Lake Kivu repeat eruptions from time to time.

I will mainly discuss vegetable production and consumption, and in addition, I wish to look into how people of the Lake Kivu area observe their crops, that is to say, what sense they have developed from their years of practical experience for growing crops. The wide variety of crops such as sorghum, cowpeas, watermelon, sesame, coffee etc. which originated on the African continent attest to the farmer's sense for an understanding of what can and cannot be successful in crop production. African farmers must have a good breeding and growing sense.

The survey was done by interviews of the farmers with filling out of questionnaires and by making a survey of cropped lands. In each area, 15 to 30 farmers were chosen at random so as to study various ways of farming. Soil in the study areas was sampled and analyzed to learn the chemical characteristics of the cropped lands. These field surveys were done over about 40 days from November 10 to December 20 in 1987.

Nowadays, the main foods eaten in this district are maize, beans, cassava, sorghum, sweet potatoes and bananas. Table 2 shows staple foods eaten among the farmers in the order of quantity consumed, who must compensate for the shortage of maize in Kashenyi and Bugobe Center. In both villages, beans are used most often to compensate for the shortage of maize, followed by cassava, sorghum and sweet potatoes, then bananas and yams which represent important staples for the people. A large percentage of the bananas are also used for making beer, banana beer being an important source of energy for the people as well as a valuable market product. The variety of banana used in making the beer is known as 'mikandili' in Kashenyi and 'magizi' in Bugobe Center, whose stem color is dark purple.

Two species of yams are also cultivated in Kashenyi, one being *Dioscorea dumetorum* (or

Table 2. Staple foods eaten among the farmers in the order of quantity consumed for the shortage of maize in Kashenyi and Bugobe Center

Farmers	Cassava	Bean	Sorghum	Sweet potato	Banana	Potato	Yam	Taro	Rice	Bread
in Kashenyi										
A	4	1	2	3	5	—	—	—	—	—
B	2	1	3	4	6	—	5	—	—	—
C	2	1	3	5	—	—	6	—	—	—
D	1	3	2	5	4	—	—	—	—	—
E	4	1	5	2	3	—	6	—	—	—
F	3	1	4	2	5	—	6	—	—	—
G	2	1	4	3	5	—	6	—	—	—
H	3	1	4	2	—	—	5	5	—	—
I	3	2	4	1	—	—	—	—	—	—
J	3	1	4	2	—	—	5	—	—	—
K	4	1	5	2	3	—	—	—	—	—
L	2	1	3	4	5	—	—	—	—	—
in Bugobe Center										
A	3	1	4	2	5	6	—	—	—	—
B	1	2	3	4	5	7	—	6	—	—
C	1	3	2	4	5	6	—	—	—	—
D	3	4	2	1	5	6	—	—	—	—
E	1	3	2	4	5	—	—	—	—	—
F	3	4	2	1	5	—	—	—	—	—
G	2	3	1	5	4	—	—	—	—	—
H	2	3	1	4	5	—	—	—	—	—
I	4	2	3	1	5	—	—	—	—	—
J	1	5	2	3	6	4	—	—	—	—

bitter yam) and the other *D. bulbifera* (or tuber yam). The farmers call the former 'iyange' in the local language. There are three varieties of the bitter yam 'ishikazi', 'kavanga', 'maligha', all of which are preferred for their particularly large tubers.

Rice and bread are never eaten by farmers in either of the villages (that is, Kashenyi and Bugobe Center). Although most of them have tasted these foods at some time in their lives, they cannot grow wheat or rice, nor do they have the purchasing power to buy rice or bread.

The farmer's family consumption of maize per day in Bugobe Center is shown in Table 3.

Table 3. Consumed maize by family per day
(in Bugobe Center)

Composition of farmers' families	Number of ears consumed per day
Eight adults + Two children	50
Two adults + Seven children	20
Two adults + One baby	10
Six adults + Three children	50
Five adults + Five children	50

This table represents maize consumption during the period from November to December 1987, the time of our survey, and may not be as high as normal for this period as they were experiencing a crop shortage at that time.

The degree of consumption of animal protein can be seen in Table 4 - a, and plant protein in Table 4 - b. In both villages fish is eaten regularly since they can buy fish caught in the Lake Kivu and Tanganika.

Table 4. The frequency of consumption of animal and plant protein taken among the families in Kashenyi and Bugobe Center

	Every week	1-2/month	Rare or No
a. Animal protein			
in Kashenyi			
Egg	0 %	17 %	83 %
Milk	0	42	58
Chicken	0	25	75
Goat, Sheep	8	42	50
Pig	30	40	30
Beef	42	42	16
Fish	67	25	8
in Bugobe Center			
Fgg	0	0	100
Milk	0	0	100
Chicken	0	10	90
Goat, Sheep	50	50	0
Beef	50	40	10
Fish	50	50	0
Pig	0	10	90
b. Plant protein			
in Kashenyi			
Bean	100 %	0 %	0 %
Groundnut	75	13	12
Pea	22	11	67
in Bugobe Center			
Bean	89	11	0
Groundnut	30	0	70
Pea	10	10	80

Beef and goat meat are another important source of animal protein, and chicken and pigs are sometimes consumed in Kashenyi but only rarely in Bugobe Center. Strangely enough, eggs and milk are rarely eaten in these regions. In these areas, the shortage of animal protein is a very serious problem. Some farmers breed rabbits for their meat, and hamsterblood is taken as a remedy for tiredness.

As for the consumption of plant protein, only beans are eaten regularly in both villages while groundnuts are sometimes cooked in palm oil with other vegetables.

II. Vegetable consumption and production

As shown in Table 5, bean leaves, cassava leaves, *Cucurbita* leaves, *Amaranthus*, taro leaves,

Table 5. The frequency of consumption of vegetables taken among the families in Kashenyi and Bugobe Center

Vegetables	Every week	1-2/month	Rare or No
in Kashenyi			
Cassava leaves	100 %	0 %	0 %
Bean leaves	100	0	0
<i>Amaranthus</i>	100	0	0
<i>Cucurbita leaves</i>	100	0	0
Onion or Shallot	92	8	0
Cabbage	77	23	0
Taro leaves	80	20	0
Tomato	89	11	0
Egg plant	0	80	20
in Bugobe Center			
Cassava leaves	82 %	9 %	9 %
Bean leaves	100	0	0
<i>Amaranthus</i>	100	0	0
<i>Cucurbita leaves</i>	90	10	0
Onion or Shallot	100	0	0
Cabbage	90	10	0
Taro leaves	67	11	12
Tomato	50	0	50
Egg plant	70	30	0

cabbage and *Solanum nigrum* are the main vegetable in these villages, and shallots and onions are also used as condiments in their diet. They also collect bean leaves from their fields which they boil then fry in heated palm oil. Cassava leaves collected from the fields are heated on the fire for about five minutes and then crushed with a wooden mortar (Plate 1). The crushed leaves are boiled in water for about two hours after which they are fried in palm oil with shallots, celery and/or chilli, and cassava leaves, called 'isumbe' in Kashenyi and 'kalala' in Bugobe Center.

The people cook *Cucurbita* leaves with shallots or onions which they fry in tomato whey. The *Cucurbita* leaves are also cooked together with meat or small dried fish. *Cucurbita* leaves are known as 'byungulira' in Kashenyi and 'chungulira' (or 'fishusha') in Bugobe Center.

Cultivated *Amaranthus* is cooked in the same way as the *Cucurbita* leaves. Wild *Amaranthus* (Plate 2) is also often used as a vegetable. They call *Amaranthus* 'lengalenga' in both villages.

Taro leaves are also used in cooking, after drying them for two to three days on the rooves of their houses.

The nutritional values of *Cucurbita* leaves, *Solanum nigrum*, cassava leaves and cabbages are shown in Table 6.

Cabbages and one particular variety of *Amaranthus* are new vegetables to the area, introduced by Europeans. Table 7. shows the list of vegetables which the people prefer and consider to be

Table 6. The nutritional value of *Cucurbita* leaves, *Solanum nigrum*,
cassava leaves and cabbage. (per 100g fresh weight)

	Protein (g)	Calcium (mg)	Iron (mg)	Beta-Carotene (μ g)	Vitamin-C (mg)
<i>Cucurbita</i> leaves	6.0	400	9.3	9,900	130
<i>Solanum nigrum</i> (leaves and stem)	6.0	300	12	9,000	140
Cassava leaves	7.0	303	7.6	11,775	311
Cabbage	1.7	50	1	100	54

Table 7. List of vegetable which they prefer and consider to be
good for health

Their preferable vegetables	Healthy vegetables
in Kashenyi <i>Amaranthus</i> , <i>Cucurbita</i> leaves, Cassava leaves, Cabbage, Bean leaves, Egg plant, Celery,	<i>Amaranthus</i> , <i>Cucurbita</i> leaves, Cassava leaves, Cabbage,
in Bugobe Center <i>Amaranthus</i> , Cassava leaves, Cabbage, <i>Solanum nigrum</i> , Bean leaves, Taro leaves,	<i>Amaranthus</i> , <i>Solanum nigrum</i> , Cabbage, Cassava leaves, Taro leaves,

good for their health.

In the dry season the farmers who don't have marshes often buy cabbages and *Amaranthus* at the market. The marshes which form in the valleys are called 'chingichingi' in Bashi language (Plate-3).

Wild weed vegetables used in cooking, for example *Solanum nigrum*, *Gynandropsis* spp, *Amaranthus* spp., 'ndedebuka' (local name), are not as numerous.

Table 8 shows the medical plant used in Kashenyi and Bugobe Ceter.

Table 8. List of medicinal plants in Kashenyi and Bugobe Center

'Cendazguina', 'Cichuchu', 'Cigowa', 'Cikanganyombwe', 'Cirindikwirhi', 'Civunjahoma', 'Cungulwishi', 'Cypres', 'Goshalulabokivi', 'Guava', 'Ifulesi', 'Ikene', 'Kabwikabulambo', 'Kafumbalugwi', 'Kahenekeru', 'Kahyola', 'Kanyamafundo', 'Kiafumbolugalu', 'Koburkabulambo', 'Kohengerehengere', 'Mudundu', 'Mufilibindi', 'Mufulubindi', 'Muibirizi', 'Mukonzi', 'Mutuzo' 'Muzanganurha', 'Quina'

III. Cropping systems of vegetables and characteristics of vegetables grown in this area

Table 9 shows the monthly change in rainfall at Buinika located near Kashenyi and Kabare

Table 9. Annual rainfall pattern in Buinika and Kabare (1930 to 1946)

Places	Altitude (m)	Rainfall/month (mm)											Total (mm)	
		J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.		D.
Buinika (near Kashenyi)	1740	138	131	149	167	128	45	22	47	112	146	148	140	1373
Kabare (near Bugobe Center)	1960	164	165	169	143	82	35	16	34	89	148	152	162	1359

near Bugobe Center. The dry season is from the middle of May to the middle of September, with a total rainfall about 1,400mm. In Kashenyi there are two sowing times in the field (except the marshes), that is September and January, while in Bugobe Center the farmers mainly sow the seeds of vegetables or plant tubers in September. The growing time in the marshes is limited to the dry season in both areas.

In Kashenyi beans planted in dry field are harvested three times a year, while in Bugobe Center they are only harvested twice. Cabbages, shallots, onions and celery are mainly grown in the marshes. Marsh soil has sufficient water content to grow crops during the dry season.

Cabbages do not flower unless they have a period of low temperature (below 10°C) for several weeks during the growing season. However, there is no such cold period in this area and therefore the cabbages do not produce seeds, so the farmers must propagate them through the cutting of the stems. Cabbage seeds are therefore largely imported from other countries, making the price of the seed very expensive (Plate 4). Most varieties of cabbages are of the European type, so it takes a long period to produce the heads (Plate 5). I feel that the people of this area should introduce a variety of cabbage which grows more quickly, such as a tropical variety.

The egg plants called 'ntolya' are different from those found in Japan. The color of the immature fruit is light green and the ripened fruit is red (Plate 6). I would assume that they belong to *Solanum gilo* from the viewpoint of the morphology of the flowers and characteristics of the fruit. The people say that the plant may have been introduced from Rwanda by the Europeans. Another species of egg plant whose scientific name is *S. macrocarpon* is planted in home gardens. Leaves of this egg plant are eaten as vegetables (Plate 7). Another species is *S. nigrum*, known as 'mulunda', which grows both as a weed and is cultivated in the fields as well.

There are three kinds of *Capsicums* in this area, *Capsicum annum*, *C. chinense* and *C. frutescens*. We can find *C. chinense* everywhere, that is at the market and in home gardens (Plate 8). The fruit has a good smell and they usually use it as a spice, crushed with palm oil or groundnut oil. The taste is very good. This *Capsicum* is called 'kabira', Another *Capsicum*, *C. frutescens*, which is used for making chilli powder, is called 'lushienda' and is older than 'kabira' in this area.

Recently large leaves of the domesticated *Amaranthus* variety 'ntendabuka', have been distributed through INERA, but the people are more fond of the wild *Amaranthus* weed. Although *Amaranthus* is commonly used as a grain in other parts of the world, the people of this

area never use it for grain.

Three Kinds of *Cucurbita* are cultivated, *Cucurbita moschata*, *C. maxima* and *C. pepo*. The people like the leaves of *C. moschata*, which are softer than those of the other species, the best.

On the subject of aroids, *Colocasia esculenta* and *Xanthosoma sagittifolium* are planted in the banana fields and marshes (Plate 9). The people call them 'bifunu', 'bishikazi', 'byecizungu' and 'nyagashago' are varieties of *C. esculenta*, while 'byamweru' are varieties of *X. sagittifolium*.

IV. Characteristics of varieties of beans, bananas and sweet potatoes as defined by farmers.

Table 10 ~ 13 show a list of the varieties of bananas, beans and sweet potatoes in Kashenyi and Bugobe Center, and their characteristics as defined by the farmers. It is very important in considering the farmers sense for growing crops that we know how these people recognize the important characteristics of their various crops. If we can come to understand how they recognize these characteristics we can comprehend at least one factor of their sense for crop growing.

In the case of bananas, people observe some or all of the following characteristics: leaf color or shape, stem size or color, plant height (dwarf etc.), growing habit, yield of fruit, level of resistance to dry soil conditions, fruit color or shape, fruit size and the use of the fruit (that is for cooking, for making beer, or as fresh fruit). Plate 10 shows some varieties of bananas in Kashenyi and Bugobe Center.

In the case of beans, the people observe some or all of the following characteristics of the bean plants: the leaf color or size, plant height, seed color or size, yield, level of resistance to heavy rain or to dry soil conditions, level of resistance to insects or diseases, pod color or size, hours required for cooking and the quality after cooking. The farmers identify the various varieties through pot color, leaf size, color or softness of leaf etc. Some varieties of beans in the both village can be seen in Plate 11.

With sweet potatoes, they observe some or all of the following characteristics: the leaf color, leaf shape, vine length, yield, level of resistance to heavy rain or dry soil conditions, level of resistance to soil erosion, tuber color, size or quality of tuber and adaptive capacity in poor soil conditions. People distinguish one variety from another by observing leaf shape, vine length, color of leaf and tuber. Some varieties of sweet potatoes in Kashenyi and Bugobe Center are in Plate 12.

V. Effect of crops on soil fertility or soil erosion and estimation of soil fertility based on the farmers' observation.

a. Effects of crops on soil fertility

The people in this area believe that various kinds of crops influence soil fertility. Table 14 shows that in Kashenyi all of the interviewed farmeres reported that bananas and sweet potatoes increase soil fertility. And they speculated that cassava, 'bifunu', sorghum and yams may increase soil fertility as well. They say the reason for the increase in soil fertility from bananas and yams is that their fallen leaves act as an organic manure, but they do not know the reason why soil fertility seems to increase in the case of the other crops mentioned above. I would guess it might be because the soil is dug up deeply at the harvest of tuber crops.

Most people believe sunflowers decrease soil fertility because the entire plant is uprooted and so the leaves or root residues do not remain in the soil.

Table 10. Characteristics of bananas defined by the farmers in Kashenyi and Bugobe Center

	Leaf size	Stem	Plan height (m)	Fruit		Identification	Others
				Size	Quality		
in Kashenyi							
Nsinabuhaka (Sinabwaka)	big	big	1.8	long	sweeter than 'magizi'	Plant height is short.	Old variety. For cooking and beer. It disappears when it is planted among other bananas.
Ciburangondo	small	red	2.5	long and a little bit curved	hard but sweet	Stem color number of fruits per regime	For cooking. New variety. It disappears when it is planted among other bananas.
Cingurube	short	—	1.5 (shortest)	same as 'kamera'	very sweet	Its leaves are very short and dwarf.	For cooking. Old variety. It disappears when it is planted among other bananas.
Cisukari	medium	green	3.0	same as 'magizi'	hard	—	For cooking and fresh resistant to disease.
Cinyamimba (Nunyamimba)	medium	—	3.0	same as 'mushaba'	bitter (fresh) sweet (after cooking)	—	For cooking. Old variety. Sap of stem is bitter.
Barhabesha	medium	—	4.0	same as 'mushaba'	sweet and soft	Plant height	For cooking. If they have no beans they use it without peeling the skin for cooking with fish or meat. It disappears when it is planted among other bananas.
Mikandili (Magizi)	medium	black	3.5 (but the other strain is 2.5m)	long (but the other strain is short)	unripened fruit is bitter	—	For making beer or cooking.
Cisanga	medium	black	3.5	shorter than 'magizi'	soft and very sweet	Fruit taste	For cooking with beans. They call the dwarf strain as 'cigenge' and the tall one as 'bashabesha'
Mushaba	medium	dark yellow	2.0	very long	sweet but hard	Fruit size	For cooking with beans. It disappears when it is planted among other bananas.
Kamera	medium	dark yellow	2.0	slender and short	sweet	—	Introduced by Belgian colonialists. Resistant to disease.
in Bugobe Center							
Cindege	medium	big	2.0	big and long	sweet	Plant height	Table banana. Introduced in 1950.
Cingurube	small but long	big	5.0	big but short	very sweet	stem color	Table banana. New variety.
Kamera	small but long	slender	3.0	small and short	very sweet	Stem color	Table banana Old variety
Bunywenge	large and long	medium	4.0	medium	good	Fruit shape	Table banana and for making beer. Introduced from Kavumu 40 years ago.
Nshika	small	big	2.5	big	good	Plant height regime is very big.	For making beer. Bitter.
Ndundu	large	big and black	5.0	medium	very good	Stem color	For making beer. Old variety.
Bukaka	large	big	6.0	big but short	good	Plant height, regime	For making beer. Old variety. Bitter.
Bulengere	large but short	big	4.0	small	not sweet (high quality for making beer)	Size of fruit	For making beer. Bitter. Old variety.
Cinamuyu	small and short	big	4.5	big but short	soft	Taste of fruit	For cooking.
Ishikazi (Mukamarha)	large and long	big	6.0	very big and short	Ripened fruit is very sweet	Leaf color and size of fruit	For making beer. Very old variety.
Musheba	large and long	big	5.0	big and long	delicious (hard)	Size of fruit	Not so old variety, for cooking.

Table 11. Characteristics of beans defined by the farmers in Kashenyi

	Leaf size	Plant height (cm)	Pod		Seed		Identification	Others
			Color	Shape or size	Color	Quality and size		
Nyamushewa	large leaves (in fertile soil)	30	green→violet with green stripes	long	green→blue and black	big, delicious	pod color	Destroyed in a non fertile soil.
Namahalagi	small	30	green→red	short	green	medium, hard	pod color	Weak to heavy rain.
Namulinbwa (Mwambuyege)	large	80	green	medium	green→red	hard	leaves shape and stem	Weak to heavy rain.
Kabenga	small	200 (climbing type)	—	long and slender	white	small, delicious easily cooked	small leaves, long and slender leaves	Weak to dry soil condition and heavy rain.
Njwijwi	large	65	green→yellow	long	white→white red	hard	Pod is the longest in this area	People use only this variety when they suffer from stomach ache.
Masugampene	small	55	green→green with brown stripes	short	white→white with black spots	medium, delicious	pod color	Weak to wet and dry soil condition.
Ishikazi	large	65	green with red stripes	long	—	delicious	large leaves and plant height	Weak to wet and dry soil condition.
Nakaberanunge	small	55	green→yellow	long	—	delicious	leaves size and color of pods	Weak to wet and dry soil condition.
Nabuzirho	small	short	green→pink	short	pink	small, delicious	Leaves become dark green on growing up	Weak to wet and dry soil condition.
Rudaheri	small	short	green	long	white	delicious	pod color	Weak to wet and dry soil condition.
Mulimbwo	little bit large	30–40	green→yellow	short	white→yellow	delicious but they are not easily cooked	pod color and soft leaves	Weak to wet and dry soil condition.
Rwandarugali	large	30–45	green→light pink	long	light pink	small, not delicious	soft leaves (Leaves of this variety is softer than other varieties.).	Weak to wet and dry soil condition.
Kabenga	medium	150 (climbing type)	green→yellow	short	white	delicious and easily cooked	climbing of vine	Weak to wet and dry soil condition.
Namweru	—	150 (climbing type)	green→yellow	long	white with black stripes	sweet and easily cooked	climbing of vine	Resistant to rain and dry soil condition.
Nabukavu	small	short	black→pink	short	—	small, not so delicious	Its leaves are small and soft in appearance.	It grows very well.
Nakaja	small	45	green→yellow	small	yellow	hard	pod size	It grows very well.
Namuhondo (Namunyu)	medium	35	green→yellow	long	brown	It has taste of salt.	leaves shape	Its name comes from taste of salt.
Mwapasteuri	small	less than that of 'njwijwi' 55	green→yellow	short	white	soft and delicious	leaves and pod are very small	Weak to rain and dry soil condition.

Table 12. Characteristics of beans defined by the farmers in Bugobe Center

	Leaf size	Plant height (cm)	Pod		Seed		Identification	Others
			Color	Shape or size	Color	Quality and size		
Kashebeiyé (climbing type)	large	200	green→yellow	long	gray with numerous black spots	big, delicious and soft	climbing	Climbing type. Old variety. Weak to heavy rain.
Namusiho	large	50	green→yellow	very long	gray→chocolate color	big, delicious and soft	size of pod	New variety.
Kagohwa	—	55	green→yellow	long	white→yellow	big, delicious and soft	—	Old variety. Weak to heavy rain.
Kashebeie (bush type)	large	80	multicolored spot	long	red with black stripes	medium size, delicious and soft	pod color	Old variety. Weak to heavy rain.
Namahalagi	large	90	green→red	short	white	big, delicious and soft	—	Old variety. Weak to heavy rain.
Naburungu	large	40	green in the bottom with brown spots	short	black and white	medium, delicious and soft	—	Old variety. Weak to heavy rain and dry soil condition.
Mwendalugali	small	35	green→red→brown	small	red	small, very delicious and soft	pod color	Old variety. Weak to heavy rain and dry soil condition.
Namuhubu	small	50	green→yellow	relatively long	green→yellow	big, delicious and soft	—	Old variety. Weak to heavy rain.
Namugoroba	large	50	green with brown spots	short	white and pink	big, delicious and soft	seed color	—
Cihongo	small	55	yellow	long	violet	big, delicious and soft	seed color	Old variety. Weak to heavy rain.
Karahata	large	75	green→yellow with red spots	long	red	relatively small, delicious and soft	seed color	Old variety. Weak to heavy rain and dry soil condition.
Kabumba	small	50	gray with green large spots	short	white with black spots	small, hard	Leaves are soft in touch and seed color	Old variety. Weak to heavy rain. Soft leaf.
Nyamusu	large	25	green→yellow	short	yellow	big, delicious and soft	—	Old variety. Weak to heavy rain. Soft leaf.
Namuko	large	45	green→yellow	long	red	big, delicious and soft	Leaves are soft in touch and seed color	Old variety. Weak to heavy rain. Soft leaf.
Lwirungu	large	40	yellow with brown spots	long	gray	big, delicious and soft	Leaves are soft in touch and seed color	Old variety. Weak to heavy rain. Soft leaf.
Itangaza	small	45	yellow with several tiny spots	short	white with red stripes	big, delicious and soft	Leaves are soft in touch and seed color	Very old variety. Weak to heavy rain. Soft leaf.
Kaliomunkangora	small	50	yellow	long	white	small, delicious and soft	Leaves are soft in touch and seed color	Very old variety. Weak to heavy rain. Soft leaf.
Njwijwi	large	50	yellow	long	red white white spots	big, delicious and soft	Leaves are soft in touch and seed color	Very old variety. Weak to heavy rain. Soft leaf.
Namweru	small	50	yellow	short	white	big, delicious and soft	Leaves are soft in touch and seed color	Very old variety. Weak to heavy rain. Soft leaf.
Kabenga	small	100	yellow	short	white	small, delicious and soft	Leaves are soft in touch and seed color	Very old variety. Weak to heavy rain. Soft leaf.

Table 13. Characteristics of sweet potatoes defined by the farmers in Kashenyi and Bugobe Center

	Leaf		Vine length (m)	Tuber		Quality	Identification	Others
	Color	Size		Inside color	Shape or size			
in Kashenyi								
Namatembera	green	medium	1.5	white	big and long	not sweet	leaf shape	Its leaves used as vegetable.
Nabirhwirhi	green with purple line on the back	large	2.0	white	round	best	leaf shape	After cooking, it becomes soft like flour. Resistant to rain but they can not produce tubers in dry season.
Namweru (Namagizi)	the same color as the leaves of coffee	small	2.5	white	very big long	delicious but not sweet	leaf shape and vine creeping	—
Namale	green with purple line on the back	medium	2.0	orange	round	sweetest	leaf shape	Strong to dry soil condition.
Ngenzamugabo	green and slightly red	medium	1.5	white	long	sweet	leaf shape	—
Nakafuma	green with purple line on the back	small	1.0	white	big	delicious	leaf shape	Planted deep fertile soil.
Chirhwiri	green with purple line on the back	small	2.0	white	round	very sweet (fresh edible)	leaf shape (leaves are short and small)	Resistant to disease.
Ngenzamugabo	green with violet line on the back	small	1.0	white	round or long	sweet and delicious	leaf shape and flowers	—
Mwarukaza	green with violet line on the back	large	1.5	white	small and long	not so sweet	leaf shape	—
in Bugobe Center								
Ndakonoko	green with violet line on the back	small	1.0	white	big and short	very sweet	—	New variety.
Cigodoka	green with violet line on the back	large	2.0	dark yellow	big	sweet but hard	size of stem and leaf	Old variety.
Namukara (Kajanga)	dark green	small	1.5	dark yellow	small and long	not sweet but soft	shape of leaf	New variety. It rapidly grows. It is not affected either by the dry and wet soil condition.
Nabunkungu	green with violet line on the back	small	0.7	dark yellow	big and short	very sweet and soft	shape of leaf	Old variety. It is not affected by heavy rain but it does not grow rapidly.
Ruzege	green with violet line on the back	large	1.0	white	—	not sweet but soft	shape of leaf	Very old. It rapidly grows.
Namudukura	green with violet line on the back	long and small	3.0	white	—	not sweet but soft	stem and leaf	Old variety. Adapted to all seasons and it grows rapidly.
Nabukarhawabo	green with violet line on the back	small	3.0	white	big	sweet and soft	—	New variety.
Muzege	green	—	3.0	white	small	sweet and delicious	shape of leaf	Old variety. It is never rotten.
Cihangalala	green on the back	large	1.0	yellow	big and short	sweet and delicious	shape of leaf	Old variety.

Table 14. Farmers' speculation of soil fertility dependent on crops

Crop	Percentage of farmers believing to increase soil fertility
Banana	100
Sweet potato	100
Cassava	94
<i>Cucurbita</i>	88
Tomato	88
Taro	87
Sorghum	87
Yam	85
Groundnut	80
Maize	73
<i>Amaranthus</i>	69
Tobacco	63
Bean	50
Soybean	31
Sunflower	0

Table 15. Farmers' speculation of defence to soil erosion dependent on crops

Crop	Percentage of farmers believing to be strong to erosion
Banana	100
Sorghum	100
Taro	100
Sunflower	100
Sweet potato	83
Maize	67
Groundnut	40
Cassava	33
Tobacco	17
Bean	0
Pea	0
Potato	0

b. Effect of crops on soil erosion

Most of the farmers indicated that bananas, sorghum, taro, sunflowers and sweet potatoes are crops which help to prevent soil erosion (Table 15). I believe this may be because bananas and sweet potatoes cover the soil with their leaves while bananas, sorghum and sunflowers roots grow very deep and so it may be that they defend the ground against soil erosion and the plants are not swept with mud.

c. Estimation of soil fertility

I would now like to discuss the estimation by farmers of soil fertility based on Dr. Kosaki's data on the characteristics of soil in Kashenyi and Bugobe Center. I asked the farmers which of their fields were the most fertile and which were the least, and then we collected soil samples from each field to be analyzed by Dr. Kosaki upon our return to Japan.

In Kashenyi the available P content in the soil of fields which the farmers considered to be especially fertile is higher than that of those fields which the farmers estimated to be low fertility fields. There is no relationship between the N content or the sum of the base elements (Ca, K, Mg, Na) in the soil, and the farmers' estimation of soil fertility (Table 16). In all the survey areas from which samples were taken, the N content in the soil is lower than the world norm. Therefore, keeping this important fact in mind, let us look at the level of the other soil elements involved.

Looking at the P content in the fields of Kashenyi, estimated by the farmers to be high in fertility, it is in fact, higher than in the fields which the farmers said to be low fertility fields. Among the high fertility fields in Kashenyi whose P content is uniform, the next determining factor in estimating the degree of field fertility is the organic carbon content in soil (Table 16).

In Bugobe Center the content of base elements in the soil is lower than it is in Kashenyi,

Table 16. Soil analysis of the low or high fertile fields estimated by farmers
in Kashenyi and Bugobe Center

Farmer's No.	pH (H ₂ O)	Org.C	N	K	Na	Ca	Mg	Sum of base elements	Avail.P (mgP ₂ O ₅ /g)	
		(%)	(meq/100g)							
in Kashenyi										
No.1	Low	5.84	1.83	0.227	1.23	0.073	6.75	3.80	11.85	0.0173
	High	5.63	1.74	0.207	0.57	0.038	7.50	2.69	10.80	0.0391
No.2	Low	5.60	3.74	0.340	1.30	0.038	9.41	3.38	14.13	0.0230
	High	5.58	3.79	0.363	0.68	0.016	6.60	4.07	11.37	0.0357
No.3	Low	4.94	2.93	0.343	0.64	0.033	3.67	0.84	5.18	0.0759
	High	5.46	3.63	0.333	1.30	0.070	9.50	2.98	13.85	0.0253
No.4	Low	5.80	2.80	0.310	0.98	0.051	10.33	4.31	15.66	0.0357
	Low	5.87	4.00	0.393	0.73	0.023	16.99	3.11	20.85	0.0230
	High	5.68	3.82	0.350	1.46	0.038	13.83	5.08	20.41	0.0989
	High	5.91	2.86	0.310	0.98	0.025	10.83	3.31	15.15	0.0851
No.5	Low	5.83	2.31	0.277	1.29	0.051	7.08	3.91	12.33	0.0460
	High	6.07	3.68	0.373	0.91	0.036	15.83	5.24	22.02	0.1978
No.6	Low	6.74	1.67	0.257	2.13	0.080	14.49	5.96	22.66	0.1311
	High	5.84	3.18	0.292	1.34	0.049	11.00	4.04	16.44	0.0207
in Bugobe Center										
No.1	Low	5.57	3.05	0.283	1.53	0.051	4.33	1.93	7.84	0.0000
	Low	5.06	2.55	0.293	1.87	0.044	2.75	0.90	5.56	0.0633
	High	5.61	2.18	0.240	0.52	0.016	7.75	3.17	11.46	0.0046
No.2	Low	5.20	3.09	0.303	0.34	0.023	5.08	1.27	6.71	0.0633
	High	5.15	4.07	0.323	0.72	0.036	5.08	1.10	6.94	0.0219
No.3	Low	4.90	2.75	0.257	0.61	0.016	2.12	0.48	3.23	0.0460
	High	5.80	3.29	0.263	1.30	0.033	8.41	2.69	12.44	0.0288
No.4	Low	5.14	2.68	0.240	0.32	0.058	4.66	1.24	6.28	0.0173
	High	5.24	3.55	0.350	0.65	0.025	5.83	1.31	7.82	0.0334

Low: low fertile field

High: high fertile field

therefore rendering in the content of base elements in the soil an important factor determining soil fertility in this village. There is no relationship between the P content and soil fertility in the fields which the farmers estimated to be highly fertile in this village, because the P content is so low in the entire area. But in the marshes which are estimated by the farmers to be highly fertile, both the base elements and the P content are uniformly rich.

In these areas, where the N content is uniformly low, I can summarise correlation between field fertility as indicated by the farmers and the data analysis from soil samples taken from foresaid fields as follows: in the areas where P content is low the level of base elements in the soil is the first determining factor in estimating soil fertility. In areas where the base elements are high, the level of the P content is the first determining factor in estimating field fertility.

Finally, in areas where both the P content and the base elements in the soil are about the same level, the organic carbon content in the soil becomes the determining factor in estimating field fertility.

The marsh is an important field for growing vegetables and the farmers estimate it to be a highly fertile area. The water content of the soil in the marshes is very high, and a special technique of cultivation is required in this area. However, so far the farmers have developed no special tools or methods for marsh cultivation. Most of them now cultivate the marshes employing dry farming techniques. This is to be expected, since they only began cultivating the marshes about ten years ago, where as they have used the dry farming system for many centuries. How effectively these farmers adapt their methods to marsh cultivation will be an important factor in crop production in this area. Table 17 shows the order which crops have been introduced into the marshes. In this areas the first crop introduced was a cash crop. Thus people owing marsh land can make money from the marshes.

Table 17. Order of crop introduced into marsh in Bugobe Center

Farmer's No.	Time of getting marsh	Order of crop introduced into marsh
No.1	1970	Taro→ <i>Amaranthus</i> →Cabbage→Bean
No.2	1972	Califlower→Cabbage→Potato→Egg plant
No.3	1974	Cabbage→Sorghum→Bean, Maize→Banana
No.4	1974	<i>Amaranthus</i> →Cabbage→Egg plant→Bean, Sorghum
No.5	1975	Cabbage→Egg plant→Bean
No.6	1975	Cauliflower→Cabbage→Potato, Egg plant→Maize
No.7	1980	<i>Amaranthus</i> , Cabbage→Leek, Carrot→Bean→Sorghum, Maize
No.8	1980	<i>Amaranthus</i> , Cabbage→Leek, Carrot→Bean→Sorghum, Maize

VI. Conclusion

In this areas the main staple foods are cassava maize, beans, sweet potatoes, sorghum and bananas. Bananas are also used in making beer. Banana beer is an important source of energy for the farmers as well as a valuable market product.

The principal vegetables used in cooking are bean leaves, cassava leaves, *Cucurbita* leaves, *Amaranthus*, taro leaves, cabbages and *Solanum nigrum*. Shallots and onions are also used as condiments.

In Kashenyi the months for sowing are September and January. In Bugobe Center it is only September. In the marshes, however, farmers grow crops in the dry season, that is, from the middle of May to the middle of September.

The farmers define the characteristics of their crops in various ways which we have not yet been able to determine.

They are highly concerned about soil fertility, especially the maintaining and increasing of soil fertility. They speculated that bananas, sweet potatoes, cassava, taro, sorghum and yams increase soil fertility. On the other hand, sunflowers decrease soil fertility.

In regard to soil erosion, bananas, sorghum, taro, sunflowers and sweet potatoes are crops which help to prevent erosion.

Data from the soil analysis of samples taken from the fields of Kashenyi and Bugobe Center

show the correlation between field fertility as indicated by farmers and mineral content in the soil as follows. Where the P content in the soil is low, the level of the base elements is the first determining factor in estimating soil fertility. In areas where the base elements are high, the level of P content is the first determining factor in estimating field fertility. When the P content and the base elements in the soil are at about the same level, the organic carbon content in the soil becomes the determining factor in estimating field fertility.

The Marsh is an important field in which they grow vegetables etc. Now they have no ideas nor tools for cultivating the marshes. For the farmers in this area information and techniques on how to grow crops in the marshes would be of great use, including the selection of the kinds of crops which can be adapted to wet soil conditions.

References

- Asahira, T. and S. Yazawa (1981) : Traditional methods of vegetable cultivation in South India and Sri Lanka. Special Report of Lab. Vegetable and Ornamental Hort., Faculty of Agr., Kyoto Univ.
- Bultot, F. (1950) : Regimes normaux et cartes des precipitations l'est du Congo Belge. Publications de l'institut national pour l'etude Agronomique du Congo Belge (I.N.E.A.C.)
- Miracle, M.P. (1967) : Agriculture in the Congo basin. Univ. Wisconsin Press.
- Sakamoto, K. (ed) : (1984) Agriculture and land utilization in the Eastern Zaire and the Southern Sudan. Section of the Principles of Agr.Sci., Dep.Agr.Forest.Econom., Faculty of Agr., Kyoto Univ.
- Suehara, T. (1983) : The labor exchange system in the Tembo. *African Study Monographs* 3:59-69.
- Shigeta, M. (1987) : Cognition, utilization and weediness of plants: Man-plant relationships in the Acholiland, Southern Sudan. *African Studies* 31:25-60.
- William, I.J. and E. Roberto (1984) Farming systems in Africa - The great lakes highlands of Zaire, Rwanda and Burundi - World bank technical paper No.27. The World Bank Washington, D.C.
- Yazawa, S. and S. Hirose (1988) : Traditional vegetable growing in the Embu District, Kenya. *Sci. Rep. Kyoto Pref. Univ., Agr.* 40:15-33.



Plate 1. Cassava crushed with a wooden mortar.

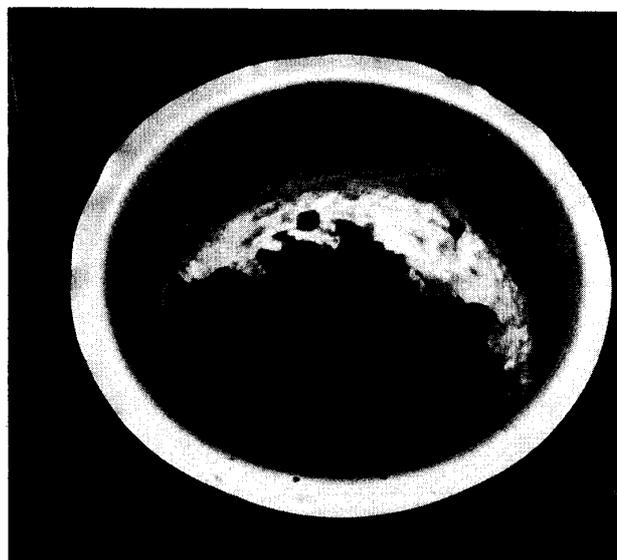


Plate 2. Wild *Amaranthus* spp. for vegetable.

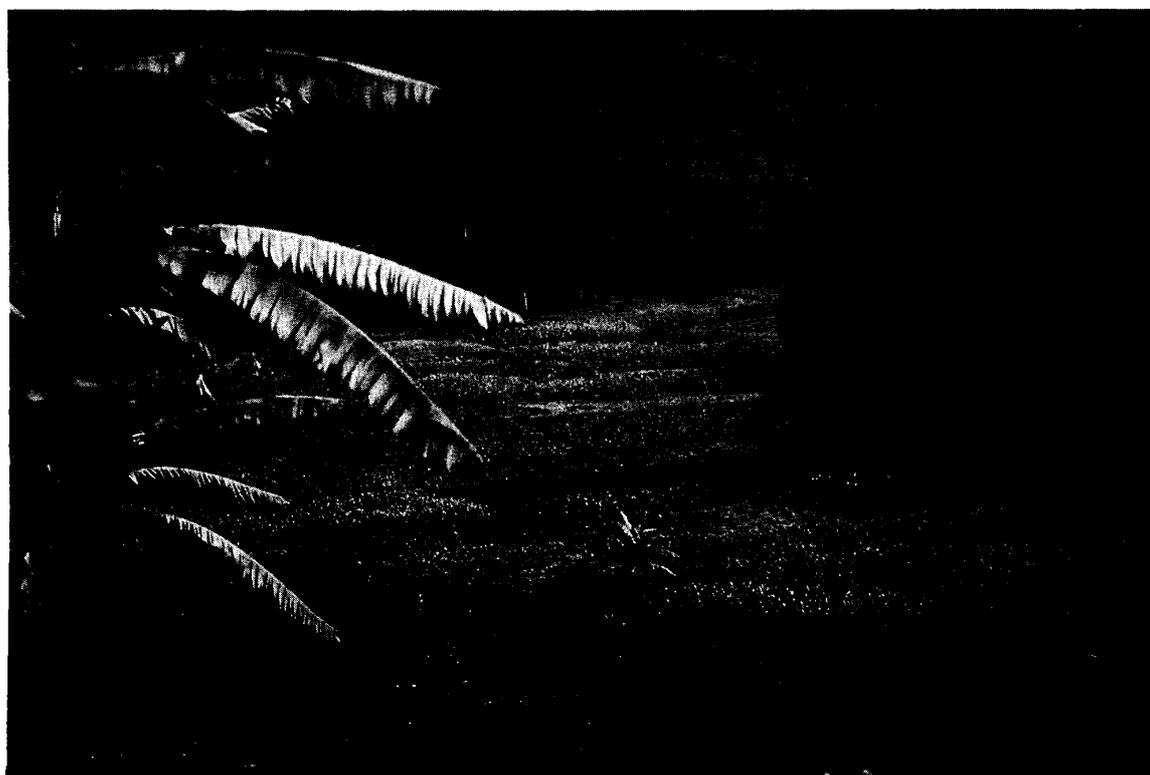


Plate 3. Marsh in Bugobe Center



Plate 4. Seed of cabbage, cauliflower and leek bought from market.



Plate 5. Growing cabbage in marsh.

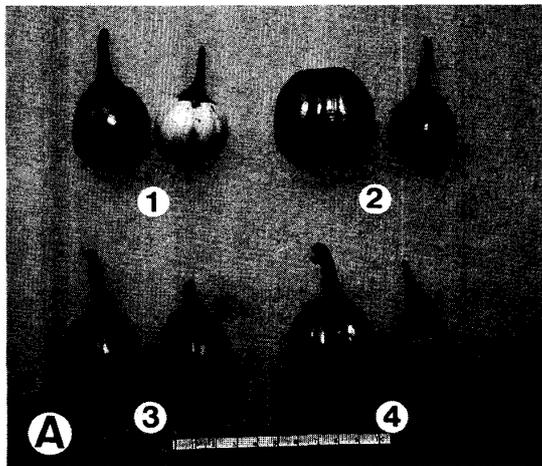


Plate 6. Egg plant (*Solanum gilo*)
A : varieties of egg plant

- 1 : 'Nyeru'
- 2 : 'Nyiru'
- 3 : 'Zalubala'
- 4 : 'Yakasi'

B : Fruiting stage





Plate 7. *Solanum macrocarpon*



Plate 8. *Capsicum chinense* at local market.

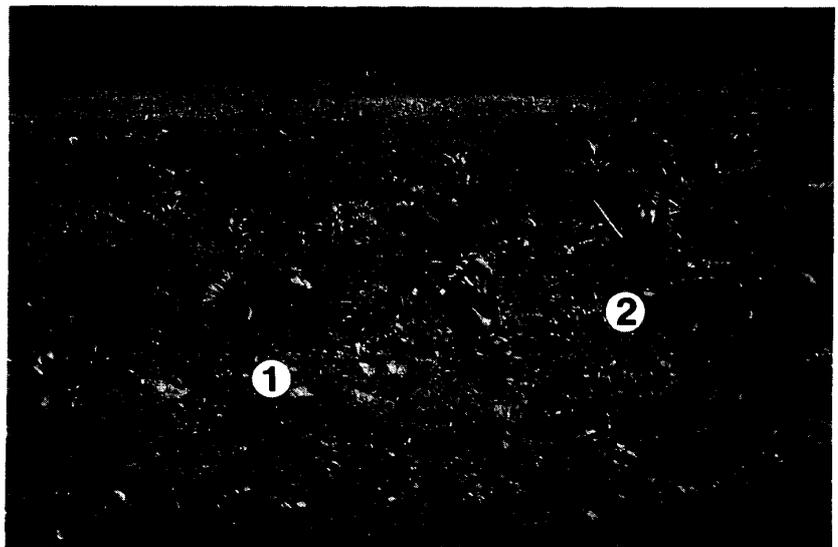
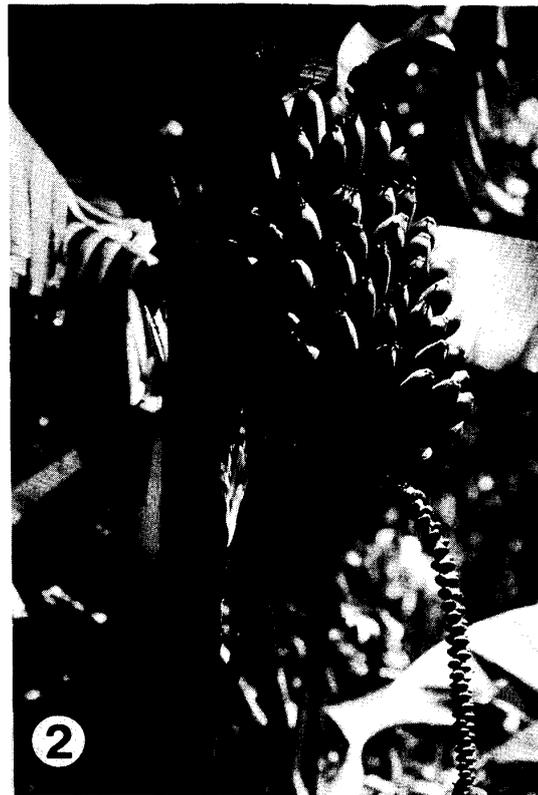


Plate 9. Growing taro and *Xanthosoma sagittifolium* in marsh.

1 : taro

2 : *Xanthosoma sagittifolium*



1, 2 : 'Mikandili' ('Magizi')



3, 4 : 'Cindege'

Plate 10. Some varieties of bananas planted in Kashenyi and Bugobe Center.



5, 6 : 'Biskali'



7, 8 : 'Bunywenge'



9 : 'Kamera'



10, 11 : 'Bulengere'



12, 13 : 'Kisamunyu'



14 : 'Mushaba'

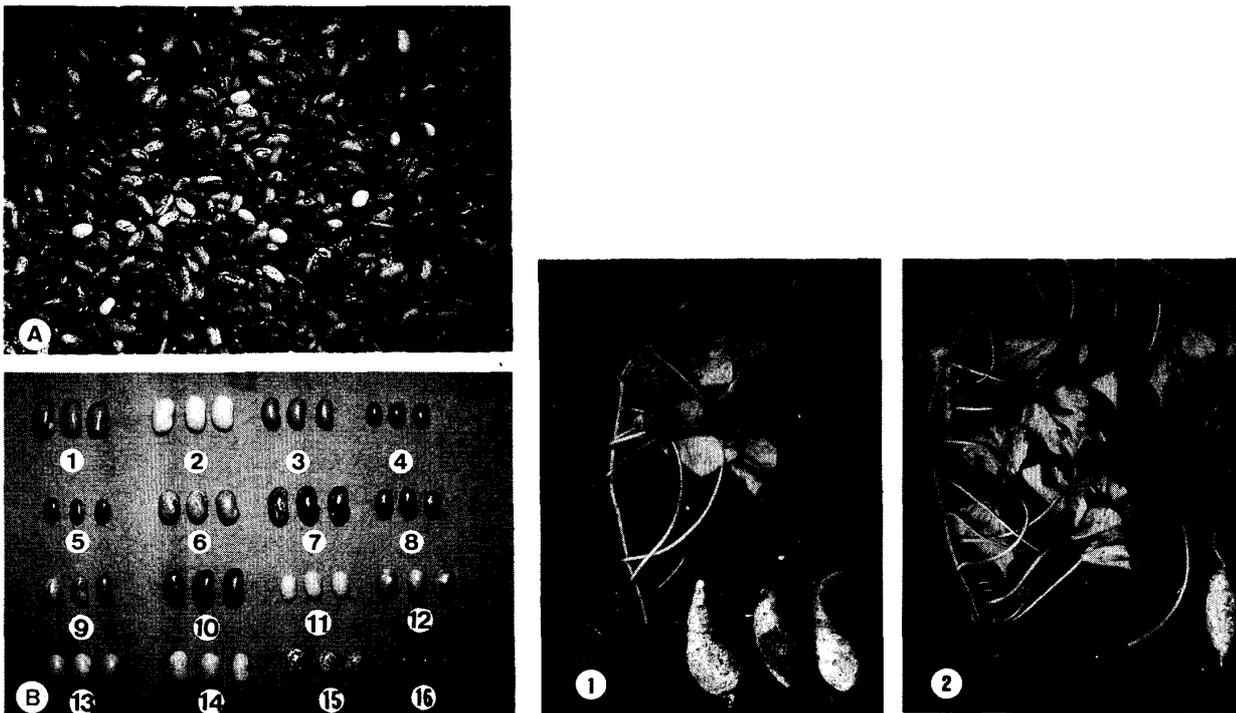


Plate 11. Some varieties of beans
planted in Kashenyi and
Bugobe Center.

A : Seed for cooking

B :

- 1 : 'Lwirungu'
- 2 : 'Namweru'
- 3 : 'Kashebeiye' (bush type)
- 4 : 'Kagohwa'
- 5 : 'Namusiho'
- 6 : 'Cihongo'
- 7 : 'Njwijwi'
- 8 : 'Kashebeiye' (climbing type)
- 9 : 'Naburungu'
- 10 : 'Namuko'
- 11 : 'Kauomunka Ngara'
- 12 : 'Itangaza'
- 13 : 'Nyamusu'
- 14 : 'Kabenga'
- 15 : 'Kabumba'
- 16 : 'Mwendalugali'

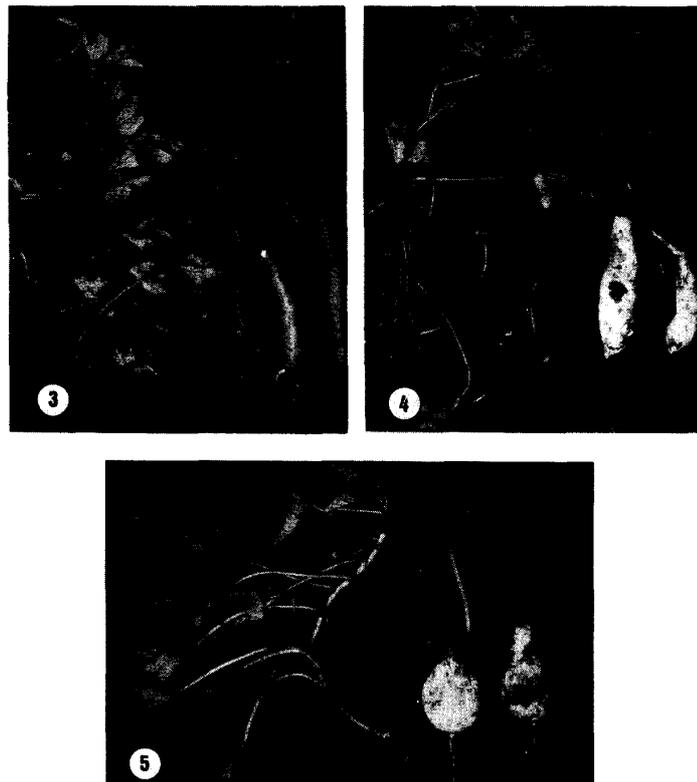


Plate 12. Some varieties of sweet potatoes planted in
Bugobe Center.

- 1 : 'Muzege'
- 2 : 'Cigodoka'
- 3 : 'Namudukura'
- 4 : 'Kajanga' ('Namukara')
- 5 : 'Nabunkungu'