CHAPTER 1

Present status of sweetpotato breeding for eastern and southern Africa

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1.1 The status of sweetpotato as a staple crop

The following overview is based on the synopses by Carey *et al*. (1997) and Minde *et al.* (1999).

Sweetpotato is an important food crop in many areas of sub-Saharan Africa where, according to FAO (FAOSTAT, 2002), it is grown on around 2.1 million ha, with an estimated production of 9.9 million tonnes. It is one of the main staples in the food systems of Uganda, Rwanda, Burundi and eastern Congo, with per capita production of around 100 kg/year. Sweetpotato is a secondary crop in the grain-based systems elsewhere in the region, becoming important only at certain times of the year or when other crops fail (Bashaasha *et al.,* 1995; Kapinga *et al.*, 1995; Scott *et al*., 2000).

According to several studies in the region, sweetpotato is grown principally for its storage roots which are generally harvested either piecemeal, or progressively, and eaten fresh, steamed or boiled. In several southern African countries the leaves are also eaten as a vegetable. In some areas that are densely populated, vines are also fed to livestock within 'cut and carry' systems. In dry areas of Tanzania and Uganda, processing of sweetpotato storage roots by slicing and

drying takes place. The dried slices form part of the dietary staple mainly during seasons of low food supply. This has become more important in areas where cassava yields have been severely reduced by African

cassava mosaic virus. Recently, the marketing of fresh sweetpotato roots, mainly in urban areas, has been gaining importance.

1.2 The main constraints to the crop in eastern and southern Africa

Farmers in the region grow a wide range of cultivars, which have principally been distributed by informal means. However, information on available cultivars is incomplete, and in most places it is difficult to determine the extent to which relatively recent cultivars introductions or escapes from breeding programmes contribute to the mix of varieties grown by farmers. It appears, however, that most cultivars are indigenous and with relatively few recent improved varieties in the regions, there are many constraints that still have to be addressed. The main constraints identified in sub-Saharan Africa are summarized in Table 1.1. Their relative importance varies with agro-ecologies, and a summary of the situation in eastern, central and southern Africa is given in Table 1.2.

Of the major constraints considered above those that might more easily be addressed by breeding are: late maturity, low yields, and perishability of the fresh roots. Breeding can also be used to produce varieties with high dry matter content and increased beta carotene content. The latter has potential for counteracting vitamin A deficiency found in many regions of sub-Saharan Africa. Much effort has been expended over the past decades to breed for insect and virus resistance, but this is a more difficult task. Another important limiting factor for the crop is the slow rate at which utilization of the crop is diversifying, which is considered to limit demand for sweetpotato in the region. (**Note**: Surveys conducted in Tanzania to identify the main constraints and focus breeding priorities are described in Chapters 2 and 3.)

Table 1.1 Major constraints to the sweetpotato crop identified in sub-Saharan Africa

Type of constraint	Constraint
Biotic	Viruses Weevils (mainly *Cylas* spp.)
Abiotic	Declining soil fertility and natural resource base
Available varieties and planting material	Lack of varieties that are high yielding, early maturing, drought resistant, have high dry matter content and have high beta carotene content Lack of good quality planting material of improved varieties
Post-harvest	Lack of storage and processing technology Lack of varieties that are less perishable Opportunity for utilization and marketing not well developed
Socio-economic and policy	Lack of policy for the production and supply of seed or planting material Lack of market studies and weak distribution systems Poor linkage between research, extension and private sector Lack of credit systems and inability of farmers to purchase inputs

Source: Hagenimana (1999).

Table 1.2 Major sweetpotato agro-ecological zones in eastern, central and southern Africa and associated production constraints

Agro-ecological zone	Major areas	Principal mode of utilization	Main identified constraints
Moist, warm environments (bimodal rainfall)	Major production zones of Kenya, Uganda, western Tanzania, Rwanda, Burundi, Zambia, Angola, Zimbabwe, Malawi	Fresh consumption and forage	Sweetpotato viral diseases (SPVD) Moles
Dry, warm environments (unimodal rainfall)	Northern Uganda, parts of Kenya, Tanzania, northern Namibia, Botswana, southern Zambia, parts of Zimbabwe and Malawi	Fresh consumption and limited processing (mainly in Uganda and Tanzania)	Weevils (*Cylas* spp.) Drought Scarcity of planting materials
Moist cool environments high elevations (bimodal rainfall)	South-west Uganda, Rwanda, Burundi, parts of Angola, Zimbabwe and Malawi	Fresh consumption and forage	*Alternaria* disease Low soil fertility

1.3 Previous breeding efforts in eastern and southern Africa

A sweetpotato breeding initiative conducted at the International Institute for Tropical Agriculture (IITA) at Ibadan, Nigeria from the early 1970s through to 1986, led to the development of a considerable number of clones with high yielding potential under low input conditions and broad adaptation to environments in Africa. The programme was based largely on elite breeding stocks from outside Africa, but selected and bred in Nigeria for resistance to regionally important constraints, including sweetpotato viral diseases (SPVD) and sweetpotato weevils (Hahn, 1982). These clones from IITA have been distributed to different places in Africa, both by IITA and, more recently, by the International Potato Center (CIP), which took over the mandate for sweetpotato in the late 1980s. CIP presently maintains 40 of the original IITA clones on its list of pathogen-tested sweetpotato cultivars for distribution (CIP, 1998). The utilization of IITA clones in east, central and southern African countries has, however, been limited. The major reasons for this are: poor consumer acceptability because of low dry matter content and poor taste, and susceptibility to local viruses; for example, in Uganda, all IITA clones introduced succumbed to SPVD. This underlines the need for localized breeding programmes that exploit the potential of local germplasm, and the importance of assessing for consumer acceptability.

In Tanzania, a sweetpotato breeding programme was established at the Lake Zone Agricultural Research and Development Institute (LZARDI), Ukiriguru, Mwanza, Lake Zone in 1968. A variety, named by the programme as SPN/O, was identified and to date the variety is widespread in eastern and southern Africa under several synonyms, including Tanzania, Kemb 10, Kasimama (Ewell, 1997). The Tanzanian programme has utilized sweetpotato germplasm from local collections, from collections outside Africa through CIP, and has also obtained germplasm from several African regions through network organizations (see section 1.4). Crossing blocks used open-pollination of seeds.

In Rwanda, at the breeding station located at the Institut Des Sciences Agronomique du Rwanda (ISAR), the varieties Rusenya and Mugande were identified between 1990 and 1994. These are indigenous varieties selected from among local farmers' varieties, but have been successful following distribution over a wide area covering Rwanda, Burundi, Kenya, Democratic Republic of Congo and other countries in the Southern Africa Development Community (SADC) region. Other clones from IITA and CIP had reached the stage of on-farm testing at the time the war began.

Selection criteria in both eastern and central African countries were based mainly on: high yield, early maturity, broad adaptation, resistance to SPVD and resistance/tolerance to sweetpotato weevils. Other considerations were good taste, high dry matter content, and attractive root shape and flesh colour. The approach differed for South Africa, as until recently, the targeted market has always been for livestock feed (Carey *et al*., 1997). Most varieties used were from USA and have lower dry matter content (18%) than is acceptable in the rest of the region.

The main lessons learned from previous breeding efforts were listed by Carey *et al*. (1997).

- Local farmers' varieties can make a significant contribution either as varieties *per se* or progenitors in breeding programmes.
- It is important to select a target environment that allows the assessment of clones for both reaction to production constraints such SPVD, and quality traits related to consumer acceptance.
- Varieties should be selected that are adapted to SPVD and *Alternaria*.
- It is important to share tasks and results among a number of countries. This is possible through networks such as the Programme Regional de la Pomme de terre et de la Patata douce en Afrique Centrale et de l'Est (PRAPACE) and the Central Africa and Southern Africa Root Crops Research Network (SARRNET) (see section 1.4). The approach minimizes the risk of having one programme in one country given the present political uncertainties and limited financial resources.

1.4 Current breeding approaches and results

In recent years, breeding efforts have been intensified in eastern, central and southern Africa, largely under the auspices of CIP and co-ordinating networks such as PRAPACE, a regional potato and sweetpotato improvement programme in eastern Africa, and SARRNET. One of the key objectives of these networks is to increase the efficiency of breeding and research into the target crops by dividing responsibilities among the participating countries.

Countries in eastern and central regions (i.e. Uganda, Rwanda, Eritrea, Kenya, Ethiopia, Burundi, Madagascar, southern Sudan, and Democratic Republic of Congo) are covered by PRAPACE. Here the responsibility for varietal screening for virus resistance and early maturity has been taken by Uganda, Kenya, Ethiopia and Democratic Republic of Congo (Carey *et al.,* 1997). SARRNET is the network for countries in the southern region (i.e. Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe). Among SARRNET participants, Malawi, Mozambique, South Africa, Tanzania and Zambia take a more active role in the breeding of new varieties. In all regions technical support is provided by CIP.

International distribution of seed populations for selection by breeding programmes has been carried out by CIP (Table 1.3). Principal sources have included the CIP breeding programmes in Peru and Indonesia, the Chinese programmes, Mississippi State University (USA), and the USDA Vegetable Research Laboratory (South Carolina, USA). In the past, the ISAR programme in Rwanda served as a source of seed for distribution both within and outside of Africa. More recently, Namulonge, Uganda and Roodeplat, South Africa have become principal sources of seed in the eastern and southern African countries. The seeds are generated from crossing blocks as well as open-pollinated fields. The parents used are both from the region as well as introductions from other countries through CIP. Kenya, having the advantage of hosting CIP, serves as the principal location for the regional redistribution of clonal germplasm by CIP from the Kenya Plant Quarantine Station at Muguga.

The introductions by country have been supported by rigorous multiplication schemes. This has enabled new germplasm to be evaluated in the national breeding trials. Results from different countries have shown that many of the clones initially selected from IITA have poor performance with respect to dry matter content, indicating the need to use regionally adapted parental clones with acceptable qualities, for example, SPN/O, Mugande, etc. In fact Mwanga (2001) has shown that most varieties selected, which have reached the advanced breeding stage, have the regionally important sweetpotato variety, SPN/O as their female progenitor.

Key elements of the regional breeding strategy as highlighted by Carey *et al*. (1997) are:

- the introduction and testing of elite varieties and seed populations from outside Africa
- the clean up (i.e. removal of viruses)[1] and distribution within Africa of varieties identified as promising or important by individual national programmes
- breeding in key agro-ecological zones to generate new varieties for the region
- the use of a farmer participatory approach and extension and NGO partners for final stages in the selection and dissemination of new varieties
- the importance of choosing parental clones from local varieties.

1.5 Current areas of focus for regional breeding efforts

For sweetpotato breeding programmes throughout the world the following objectives are given high priority.

- Breeding for high yield in terms of dry matter per unit of land and time.
- Breeding for resistance to, and cultural control of, economically important diseases and pests.

Table 1.3 Sweetpotato germplasm distributed by CIP to eastern, central and southern Africa countries 1993–2002

Country of destination	Source of germplasm			Number of seed families received
	South America	North America	Other countries	
Angola	16	4	21	-
Burundi	2	-	4	
Botswana	17	4	13	-
DR Congo	20	17	36	-
Eritrea	-	-	18	-
Ethiopia	-	-	26	-
Madagascar	-	-	4	-
Malawi	-	-	20	29
Mozambique	-	-	28	-
Kenya	73	41	171	265
Rwanda	34	21	41	92
Sudan	6	4	29	-
Tanzania	28	7	60	149
Uganda	83	34	116	117
Zambia	11	3	48	234

Source: CIP and SARRNET reports for 1999, 2000 and 2001/02.

[1]The removal of virsues from a cultivar is a complex process which involves producing callus material, heating to kill the viruses, and the production of plantlets from the callus. This process can be carried out at CIP in Peru and is recommended before material is moved between regions, to prevent the spread of viruses.

Table 1.4 Main breeding goals by region after assessment of constraints and opportunities

Factor	CIP region			
	Latin America	South-west Asia	East and southern East Asia and the Pacific	Sub-Saharan Africa
Weevil resistance/tolerance		X	X	X
Virus resistance				X
Drought tolerance	X	X	X	X
High dry matter (starch) content	X		X	X
High foliage yield	X*	X*		X*
Non-sweet storage roots				West Africa
Good storability	X	X		X

*Potential demand for forage-type sweetpotato (forage only).

Source: CIP (1995).

- Breeding for high keeping qualities.
- Breeding for improved quality in terms of consumer acceptance, processing and nutritional values.
- Breeding for wide adaptation.

Table 1.4 summarizes global breeding priorities as set by sweetpotato breeders in a workshop held by CIP in Lima, Peru in June 1994 (CIP, 1995).

For eastern and southern Africa primary and secondary focus areas have been highlighted by Carey *et al.* (1997).

Primary

In addition to assuring widespread dissemination of released varieties, the major objectives are to select varieties with acceptable utilization characteristics. These characteristics include:

- acceptable taste, high dry matter content, etc.
- suitability for improved farm-level processing
- extended shelf-life of roots and tolerance to market conditions
- attractive appearance and properties of products, particularly flour
- ability to produce vines for animal feed.

Secondary

These are selected mainly on the basis of testing in the major production environments. Important areas are:

- earliness vs. inground storability
- drought tolerance
- high root yield
- good establishment
- good resistance to SPVD and sweetpotato weevils.

Breeding procedures both on-farm and on-station are summarized in *CIP Research Guide* Nos 5 and 6 (Fonseca *et al.,* 1994; Carey and Reynoso, 1997). An overview is also given in Appendix I.

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